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	Shunpei YAMAZAKI	)
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For:	LIGHT-EMITTING DEVICE, FILM-FORMING METHOD AND MANUFACTURING APPARATUS THEREOF, AND CLEANING METHOD OF THE MANUFACTURING APPARATUS	)

VERIFICATION OF TRANSLATION

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Sir:

I, Azusa Kikuchi, C/O Semiconductor Energy Laboratory Co., Ltd. 398, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached English translation of the Japanese Patent Application No. 2002-361320 filed on December 12, 2002; and

that to the best of my knowledge and belief the following is a true and correct English translation of the Japanese Patent Application No. 2002-361320 filed on December 12, 2002.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 18th day of July 2008

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[List of Attachment]

[Attachment] Specification 1

[Attachment] Drawing 1

[Attachment] Abstract 1

[Proof] Required

[Name of Document] Specification

[Title of Invention] LIGHT EMITTING DEVICE, FILM FORMING APPARATUS, AND FILM FORMING METHOD

[Scope of Claims]

[Claim 1]

A light emitting device characterized by comprising:

a light emitting device which has an anode over a substrate having an insulation surface, a layer containing an organic compound, which is in contact with the anode, a cathode which is in contact with the layer containing the organic compound,

wherein in the layer containing the organic compound, contained is silicon with 1×10^{18} to 5×10^{20} pieces/cm^{-3} by SIMS measurement.

[Claim 2]

The light emitting device according to claim 1, characterized in that in the layer containing the organic compound, contained is silicon with 3×10^{18} to 3×10^{20} pieces/cm^{-3} by SIMS measurement.

[Claim 3]

A film forming apparatus which deposits an organic compound material from a vapor deposition source placed so as to face a substrate, to carry out film formation over the substrate, characterized in that:

in a film forming chamber in which the substrate is placed, the vapor deposition source which accommodates the organic compound material and means for heating the vapor deposition source are provided, and

the film forming chamber is coupled to a vacuum exhausting processing chamber which evacuates the film forming chamber, and has means which can

introduce a material gas.

[Claim 4]

A film forming apparatus which has a load chamber, a transport chamber coupled to the load chamber, and a film forming chamber coupled to the transport chamber, characterized in that:

the transport chamber has a function of carrying out alignment of a mask and a substrate,

in the film forming chamber in which the substrate is placed, a vapor deposition source which accommodates an organic compound material and means for heating the vapor deposition source are provided, and

the film forming chamber is coupled to a vacuum exhausting processing chamber which evacuates the film forming chamber, and has means which can introduce a material gas.

[Claim 5]

The film forming apparatus according to claim 3 or 4, characterized in that the vapor deposition source is movable in an X direction or a Y direction in the film forming chamber.

[Claim 6]

The film forming apparatus according to any one of claims 3 to 5, characterized in that in the film forming chamber, means for heating the substrate is provided.

[Claim 7]

The film forming apparatus according to any one of claims 3 to 6, characterized in that the means which can introduce a material gas is means which introduces a radicalized material gas by a plasma generating means.

[Claim 8]

The film forming apparatus according to any one of claims 3 to 7, characterized in that the material gas is one kind or plural kinds selected from monosilane, disilane, trisilane, SiF_4, GeH_4, GeF_4, SnH_4, CH_4, C_2H_2, C_2H_4, and C_6H_6.

[Claim 9]

A film forming method for having an organic compound deposited over a substrate placed in a film forming chamber, characterized in that on the occasion that an inside of the film forming chamber is made to be under higher vacuum than 1×10^{-3} Torr, and a film is formed over the substrate by having an organic compound material deposited from a vapor deposition source placed so as to face the substrate, a material gas is introduced into the film forming chamber at the same time.

[Claim 10]

A film forming method for having an organic compound deposited over a substrate placed in a film forming chamber, characterized in that on the occasion that an inside of the film forming chamber is made to be under higher vacuum than 1×10^{-3} Torr, and a film is formed over the substrate by having an organic compound material deposited from a vapor deposition source placed so as to face the substrate, a radicalized material gas is introduced into the film forming chamber at the same time.

[Claim 11]

The film forming method according to claim 9 or 10, characterized in that the material gas is one kind or plural kinds selected from monosilane, disilane, trisilane, SiF_4, GeH_4, GeF_4, SnH_4, CH_4, C_2H_2, C_2H_4, and C_6H_6.

[Claim 12]

A film forming method for having an organic compound deposited over a substrate placed in a film forming chamber, characterized in that on the occasion that

an inside of the film forming chamber is made to be under higher vacuum than 1×10^{-3} Torr, and a film is formed over the substrate by having an organic compound material deposited from a deposition source placed so as to face the substrate, while an ionized material is evaporated by plasma at the same time to be chemically attached to the organic compound material, film formation is carried out over the substrate.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention pertains]

This invention relates to a film forming apparatus and a film forming method, which are used for film formation of a material (hereinafter referred to as a vapor deposition material) which can be formed as a film by vapor deposition. In particular, this invention is a technology which is effective in the case of using a material which contains an organic compound, as a vapor deposition material.

[0002]

[Prior Art]

In recent years, research of a light-emitting device which has an EL element as a self-luminous type element has been intensified, and in particular, a light emitting device which uses an organic material as an EL material has been attracting attention. This light emitting device is also called an organic EL display or an organic light emitting diode.

[0003]

Note that an EL element has a layer (hereinafter referred to as an EL layer) containing an organic compound that provides luminescence (electroluminescence) generated by applying an electric field, an anode, and a cathode. The luminescence in the organic compound includes light emission (fluorescence) on the occasion of

returning from the singlet-excited state to the ground state, and light emission (phosphorescence) on the occasion of returning from the triplet-excited state to the ground state, and a light emitting device fabricated by a film forming apparatus and film forming method of this invention can be applied to a case in which either light emission is used.

[0004]

A light emitting device has such a characteristic that there is no problem of a viewing angle since it is of a self-luminous type, unlike a liquid crystal display device. That is, it is more suitable as a display which is used outdoors than a liquid crystal display, and uses in various forms have been proposed.

[0005]

An EL element has such a structure that an EL layer is sandwiched between a pair of electrodes, and the EL layer normally has a laminated structure. Typically, a laminated structure of "a hole transport layer/a light emitting layer/an electron transport layer" is cited. This structure is of very high luminous efficiency, and most of the light emitting devices, for which researches and developments have been advanced at present, adopt this structure.

[0006]

Alternatively, a laminated structure of a hole injecting layer/a hole transport layer/a light emitting layer/an electron transport layer or a laminated structure of a hole injecting layer/a hole transport layer/a light emitting layer/an electron transport layer/an electron injecting layer over an anode may be employed. The light emitting layer may be doped with a fluorescent pigment or the like. Further, all of these layers may be formed using a low molecular material or a high molecular material.

[0007]

Note that in this specification, all layers provided between a cathode and an anode are collectively referred to as an EL layer. Therefore, the hole injecting layer, the hole transport layer, the light emitting layer, the electron transport layer, and the electron injecting layer are all included in the EL layer.

[0008]

Further, light-emitting elements each including a cathode, an EL layer, and an anode are called EL elements, which include two types: one is that in which an EL layer is formed between two kinds of stripe electrodes arranged at right angles to each other (simple-matrix type), and the other is that in which an EL layer is formed between pixel electrodes that are connected to TFTs and arranged in matrix, and an opposed electrode (active matrix type).

[0009]

The biggest problem in practical application of an EL element is that life of the element is insufficient. Also, deterioration of the element appears in such a form that a non-luminous region (dark spot) is broadened as the element is made to emit light for a long time, and as its cause, deterioration of the EL layer has become an issue.

[0010]

An EL material which forms the EL layer is deteriorated by impurities such as oxygen and water. In addition, it is also conceivable that other impurities are included in the EL material, which could affect deterioration of the EL layer.

[0011]

In addition, the EL material is broadly classified into a low molecular (monomer) material and a high molecular (polymer) material, and the low molecular material among them is formed as a film, mainly by vapor deposition. A vacuum

vapor deposition method in which a film is formed by evaporating an evaporation material from an evaporation source in vacuum is known as a typical example of a physical film forming method. In addition, as a typical example of a chemical film forming method, known is a CVD (chemical vapor deposition) method in which a film is formed by supplying a material gas over a substrate and chemical reaction in the gaseous phase or over the substrate surface.

[0012]

On the occasion of carrying out film formation by a conventional vapor deposition method, an evaporation material is used as it is, but it is conceivable that an impurity is mixed in an evaporation material at the time of vapor deposition. That is, there is such a possibility that oxygen, water, and any other impurity, which is one of deterioration causes of an EL element, may be mixed in.

[0013]

Further, it is possible to improve purity by purify an evaporation material in advance, but there is also such a possibility that an impurity may be mixed in during a period until it is deposited.

[0014]

An EL material is very easily deteriorated, and it is easily oxidized and deteriorated due to existence of oxygen or water. On that account, it is impossible to carry out a photolithography process after film formation, and in order to develop a certain pattern, there is such a necessity that a mask having an opening part (hereinafter referred to as a vapor deposition mask) be used and it be separated at the same time as film formation. Therefore, most of the sublimed organic EL materials are attached to a vapor deposition mask or an anti-attachment shield (a protection plate for preventing a vapor deposition material from being attached to an inner wall of a

film forming chamber) in a film forming chamber.

[0015]

[Problems to be Solved by the Invention]

This invention is made in view of the above-described problems, and an object of this invention is to provide a film forming apparatus which is of high throughput and can form a high-density EL layer. Further, another object is to provide a film forming method which uses the film forming apparatus of this invention.

[0016]

[Means for Solving the Problem]

This invention provides such a new film forming method that, on the occasion of evaporating an organic compound material from an evaporation source to form a film, in a film forming chamber, with 5×10^{-3} Torr (0.665 Pa) or less, preferably 1×10^{-3} Torr (0.133 Pa) or less, which is set by depressurizing means which is connected to the film forming chamber, a minute amount of gas containing smaller particles than particles of the organic compound material, i.e., a material with a small atomic radius, is flowed, and the material with a small atomic radius is contained in an organic compound film. Reliability is improved by intentionally making an inorganic material be contained in the organic compound film.

[0017]

That is, this invention forms a high-density film by intentionally introducing a material gas at the time of film formation and by making a component of the material gas be contained in the organic compound film, and blocks an impurity such as oxygen and moisture which induces deterioration from invading and diffusing in a film.

[0018]

As the above-described material gas with a small atomic radius, concretely speaking, one kind or plural kinds selected from silane series gas (monosilane, disilane, trisilane, and the like), SiF_4, GeH_4, GeF_4, SnH_4, and hydro carbon series gas (CH_4, C_2H_2, C_2H_4, C_6H_6, and the like), may be used. Note that also included is a mixed gas in which these gasses are diluted by hydrogen, argon, or the like. As these gasses, which are introduced into an apparatus, used is one which is highly purified by a gas purification machine before it is introduced into the apparatus. Therefore, there is such a necessity that the gas purification machine be provided in order that a gas is introduced after it is highly purified. Thus, since it is possible to remove a residual gaseous body (oxygen, moisture, other impurities, and the like) which is contained in the gas in advance, it is possible to prevent these impurities from being introduced into the apparatus.

[0019]

In addition, a component of a material gas introduced by heating a substrate may be effectively deposited over the substrate.

[0020]

In addition, it may be radicalized by a plasma generating means. For example, in the case of monosilane, by a plasma generating means, generated is an oxide silicon precursor such as SiHx, SiHxOy, or SiOy, and these are deposited over a substrate together with an organic compound material from an evaporation source. Monosilane is easily reacted with oxygen and moisture, and makes it possible to reduce an oxygen concentration and a moisture amount in a film forming chamber.

[0021]

A structure of this invention, which is disclosed in this specification, is a light emitting device which is equipped with a light emitting element which has an anode

over a substrate having an insulation surface, a layer which contains an organic compound and is in contact with the anode, a cathode which is in contact with the layer which contains the organic compound, and the light emitting device is characterized in that, in the above described layer containing the organic compound, contained is silicon with 1×10^{18} to 5×10^{20} pieces/cm^{-3}, preferably 3×10^{18} to 3×10^{20} pieces/cm^{-3} by SIMS measurement.

[0022]

In the case where a material gas is reacted with oxygen and moisture, like a silane series gas, it is possible to reduce an oxygen concentration and a moisture amount in a film forming chamber and thus to obtain a highly reliable organic compound film. Note that for a plasma generation method, it is possible to properly use ECR, ICP, helicon, magnetron, dual-frequency, triode, LEP, or the like.

[0023]

Also, in this specification, a new film forming apparatus is provided.

[0024]

A structure regarding a film forming apparatus of this invention is a film forming apparatus which deposits an organic compound material from a vapor deposition source placed so as to face a substrate and forms a film over the substrate, and the film forming apparatus is characterized in that, in a film forming chamber in which the substrate is placed, a deposition source which accommodates the organic compound material and a means for heating the vapor deposition source are provided, and the film forming chamber is coupled to a vacuum exhaust process chamber which evacuates the film forming chamber, and has a means which can introduce a material gas.

[0025]

In addition, by using the film forming apparatus of this invention, it is possible to make a multi-chamber system film forming apparatus, and a film forming apparatus of this invention is a film forming apparatus which has a load chamber, a transport chamber which is coupled to the load chamber, and a film forming chamber which is coupled to the transport chamber, and the film forming apparatus is characterized in that the transport chamber has a function of carrying out alignment of a mask (vapor deposition mask) and a substrate, in the film forming chamber in which the substrate is placed, a vapor deposition source which accommodates an organic compound material and a means for heating the vapor deposition source are provided, and the film forming chamber is coupled to a vacuum exhaust process chamber which vacuates the film forming chamber, and has means which can introduce a material gas.

[0026]

Further, it is desirable that, as the vapor deposition mask, a metal material which is hard to be transformed by heat (the coefficient of thermal expansion is low) and can withstand the temperature at the time of vapor deposition (e.g., high-melting metal such as tungsten, tantalum, chromium, nickel, or molybdenum, an alloy containing any of these elements, stainless steel, inconel, hastelloy, or the like) be used. For example, a low thermal expansion alloy containing 42% of nickel and 58% of iron (42 alloy), a low thermal expansion alloy containing 36% of nickel (36 inver) each of which has the coefficient of thermal expansion, which is approximately equal to that of a glass substrate (0.4×10^{-6} to 8.5×10^{-6}), and the like are cited.

[0027]

In addition, by using the film forming apparatus of this invention, it is also possible to make an inline system film forming apparatus in which a load chamber, a transport chamber, and a film forming chamber are coupled in a serial direction.

[0028]

In addition, each structure of the above-described film forming apparatus is characterized in that the vapor deposition source can be moved in an X direction or a Y direction in the film forming chamber, on an even keel. In addition, on the occasion of vapor deposition, a spacing distance *d* of a substrate and a vapor deposition source holder is narrowed to typically 30 cm or less, preferably 20 cm or less, more preferably 5 cm to 15 cm, to dramatically improve utilization efficiency of a vapor deposition material and throughput. The vapor deposition source holder is composed of a container (typically, a crucible), a heater disposed outside the container through a soak member, a heat insulating layer disposed outside this heater, an outer tube which accommodates these, a cooling pipe wound around the outer tube, a vapor deposition shutter which opens and closes an opening part of the outer tube including an opening part of the crucible, and a film thickness sensor.

[0029]

In addition, in each structure of the above-described film forming apparatus, in the film forming chamber, a means for heating the substrate may be provided. In addition, as the means for heating the substrate, it is possible to heat by having a stage at which a heater, a heating wire, or the like is disposed (may have a function of fixing the substrate), or a metal mask at which a heater, a heating wire, or the like is disposed, closely contacted with or come close to the substrate, and it is possible to set a temperature of the substrate to 50 to 200°C, preferably 65 to 150°C. By heating the substrate, a component of the material gas can be easily imported in an organic compound film.

[0030]

In addition, each structure of the above-described film forming apparatus is

characterized in that the above-described means which can introduce the material gas is a means for introducing a material gas which was radicalized by a plasma generating means. In addition, separately from a system which introduces a material gas, a system which introduces an inert gas for keeping at normal pressures in the film forming chamber may be provided.

[0031]

In addition, at the time of vapor deposition, plasma may be formed by carrying out electric discharge by an antenna system in the film forming chamber, and a component of the ionized material gas is chemically attached to the evaporated organic compound.

[0032]

In addition, in each structure of the above-described film forming apparatus, the vacuum exhausting means which is disposed so as to be coupled to the film forming chamber evacuates to a pressure approximately 1 Pa lower than an atmospheric pressure by an oil-free dry pump, and evacuates to a pressure lower than that by a magnetic levitation type turbo molecular pump or a complex molecular pump. In the film forming chamber, for the purpose of removing moisture, a cryopump may also be disposed. Thus, contamination due to an organic substance such as, mainly, oil is prevented from the exhausting means. An inner wall surface is processed as a mirror surface by electrolytic polishing and thus a surface area is reduced, so that gas discharge is prevented.

[0033]

In addition, in the above-described each film forming apparatus, by disposing a plurality of vapor deposition sources in one film forming chamber, it is possible to form a plurality of functional regions, and a light emitting element which has a mixed

region, in the same film forming chamber. Therefore, in the case where an organic compound film which is composed of a plurality of functional regions is formed between an anode and a cathode of a light emitting element, it is possible to form a structure having a mixed region which is composed of both of a material which forms a first functional region and a material which forms a second functional region, between the first functional region and the second functional region, instead of a conventional laminated structure in which a distinct interface exists. By this invention, by having a component of a material gas contained in a film by introducing the material gas prior to film formation or during a period of film formation, it is possible to further fit molecules in the mixed region. By forming the mixed region, an energy barrier between functional regions is mitigated. Therefore, reduction in a drive voltage and prevention of luminance lowering become possible.

[0034]

Note that a first organic compound and a second organic compound have properties which are selected from a group of a hole injection property for accepting a hole from an anode, a hole transport property in which hole mobility is higher than electron mobility, an electron transport property in which electron mobility is higher than hole mobility, an electron injection property for accepting an electron from a cathode, a blocking property for blocking a move of a hole or an electron, and a light emission property for showing light emission, and they have the above-described properties which are different from each other.

[0035]

Note that as an organic compound in which the hole injection property is high, a phthalocyanine series compound is preferable, and as an organic compound in which the hole transport property is high, an aromatic diamine compound is preferable, and in

addition, as an organic compound in which the electron transport property is high, a metal complex including a quinoline bone structure, a metal complex including a benzoquinoline bone structure, an oxadiazole derivative, triazole derivative, or a phenanthroline derivative is preferable. Further, as an organic compound which shows light emission, a metal complex including a quinoline bone structure, a metal complex including a benzoxazole bone structure, or a metal complex including a benzothiazole bone structure, which emits light stably, is preferable.

[0036]

It is more preferable to configure a luminescent region with a host material, and a luminescent material (dopant) in which excitation energy is lower than that of the host material, and to design in such a manner that excitation energy of the dopant becomes lower than excitation energy of a hole transport property region and excitation energy of an electron transport layer. Thus, it is possible to prevent diffusion of molecular exciters of the dopant, and to have the dopant emit light effectively. In addition, if the dopant is a carrier-trap type material, it is possible to also heighten recombination efficiency of a carrier.

[0037]

In addition, it is assumed that such a case that a material, in which triplet excitation energy can be converted into light emission, is added to a mixed region as a dopant is included in this invention. In addition, in forming the mixed region, concentration gradient may be applied to the mixed region.

[0038]

Note that the film forming apparatus in this invention can be used not only for film formation of an organic compound typified by an EL material, but also for film formation of another material such as a metal material which is used for vapor

deposition.

[0039]

In addition, in this specification, a new film forming method is also provided.

[0040]

A structure regarding a film forming method of this invention is a film forming method for depositing an organic compound over a substrate placed in a film forming chamber, and the film forming method is characterized in that an inside of the film forming chamber is made to be under higher vacuum than 1×10^{-3} Torr, and on the occasion of carrying out film formation over the substrate by depositing an organic compound material from a vapor deposition source placed so as to face the substrate, a material gas is introduced into the film forming chamber at the same time.

[0041]

In addition, another structure regarding the film forming method of this invention is a film forming method for depositing an organic compound on a substrate placed in a film forming chamber, and the film forming method is characterized in that an inside of the film forming chamber is made to be under higher vacuum than 1×10^{-3} Torr, and on the occasion of carrying out film formation over the substrate by depositing an organic compound material from a vapor deposition source placed so as to face the substrate, a material gas, which has been radicalized, is introduced into the film forming chamber at the same time.

[0042]

In addition, the above-described each structure is characterized in that the material gas is of one kind or plural kinds selected from monosilane, disilane, trisilane, SiF_4, GeH_4, GeF_4, SnH_4, CH_4, C_2H_2, C_2H_4, and C_6H_6.

[0043]

In addition, a phosphin gas may be introduced in addition to monosilane. Alternatively, instead of monosilane, it is possible to use any of various gases indicated by AsH_3, B_2H_2, BF_4, H_2Te, $Cd(CH_3)_2$, $Zn(CH_3)_2$, $(CH_3)_3In$, H_2Se, BeH_2, trimethyl gallium, and triethyl gallium.

[0044]

In addition, as a layer containing an organic compound, which is placed between a cathode and an anode, typical is an example in which three layers of a hole transport layer, a light emitting layer, and an electron transport layer are laminated, but it is not restrictive in particular, and a structure of laminating in the order of a hole injection layer/a hole transport layer/a light emitting layer/an electron transport layer, or a hole injection layer/a hole transport layer/a light emitting layer/an electron transport layer/an electron injection layer, on the anode, a two-layer structure, or a single-layer structure may be employed. The light emitting layer may be doped with a fluorescence pigment. Further, as the light emitting layer, there are also a light emitting layer having a hole transport property, a light emitting layer having an electron transport property, and the like. In addition, all of these layers may be formed by using a low molecular material, and one layer or several layers among them may be formed by using a high molecular material. Note that in this specification, all layers which are disposed between the cathode and the anode are collectively called a layer containing an organic compound (EL layer). Therefore, the above-described hole injection layer, the hole transport layer, the light emitting layer, the electron transport layer, and the electron injection layer are all included in the EL layer. In addition, the layer containing the organic compound (EL layer) may include an inorganic material such as silicon.

[0045]

Note that a light emitting element (EL element) has a layer containing an organic compound in which obtained is luminescence (electroluminescence) which is generated by applying an electric field (hereinafter referred to as an EL layer), an anode, and a cathode. As luminescence in an organic compound, there are light emission (fluorescence) on the occasion of returning from a singlet excitation state to a ground state, and light emission (phosphorescent) on the occasion of returning from a triplet excitation state to the ground state, and a case in which either light emission is used is applicable to a light emitting device which is fabricated by this invention.

[0046]

In addition, in the light emitting device of this invention, a drive method of screen display is not restrictive in particular, and for example, a point sequential driving method, a line sequential driving method, a plane sequential driving method, or the like may be used. Typically, the line sequential driving method is used, and a time division tone driving method and an area tone driving method may be used properly. In addition, a video signal which is inputted into a source line of a light emitting device may be an analog signal or a digital signal, and a drive circuit and the like may be designed properly in accordance with the video signal.

[0047]

In addition, in this specification, a light emitting element formed of a cathode, an EL layer, and an anode is called an EL element, and as to this, there are two types of systems: a system in which the EL layer is formed between two types of stripe shaped electrodes (simple matrix system), and a system in which the EL layer is formed between pixel electrodes connected to TFTs and arranged in matrix, and opposed electrodes (active matrix system).

[0048]

[Embodiment Mode of the Invention]

Embodiment modes of this invention will be hereinafter described.

[0049]

(Embodiment Mode 1)

A structure of a film forming apparatus in this invention will be described by use of FIG.1. FIG.1 is one example of a cross-sectional view in the film forming apparatus of this invention.

[0050]

On the occasion of carrying out film formation by a vapor deposition method, it is preferable to use a face-down system (also called a depo-up system), and a substrate 10 is set with a surface on which a film is to be formed facing downward. The face-down system refers to a system in which film formation is carried out with a surface of the substrate, on which a film is to be formed, facing downward, and by this system, it is possible to suppress attachment of dust.

[0051]

As shown in FIG.1, in contact with the substrate 10, a heating means, here, a heater is provided with a substrate holder 12. By the heating means, it is possible to set a temperature of the substrate to 50 to 200°C, preferably 65 to 150°C. In addition, the substrate 10 is fixed by being sandwiched by metal masks (not shown), by a permanent magnet built into the substrate holder. In addition, on a level block 18 disposed in a film forming chamber, vapor deposition cells (also called vapor deposition holders) 13, which are also capable of being heated to temperatures different from each other, are disposed. Note that a vapor deposition source is disposed so as to be opposed to the substrate. Here, shown is an example in which the substrate is fixed by being sandwiched by metal masks by use of the permanent

magnet, but it may be fixed by a holder.

[0052]

Here, the vapor deposition source is composed of the vapor deposition cells 13, a container which accommodates an organic compound (a crucible, a deposition board, or the like), a shutter 14, a heating means for heating the organic compound, and a heat insulating material for surrounding a periphery. As the heating means, a resistance heating type is basically used, but a Knudsen cell may alternatively be used.

[0053]

In addition, to the film forming chamber, coupled are a gas introduction system which introduces a material gas by several sccm into the film forming chamber at the time of vapor deposition, and a gas introduction system which makes an inside of the film forming chamber be at normal pressures. As the material gas, used are one kind or plural kinds selected from monosilane, disilane, trisilane, SiF_4, GeH_4, GeF_4, SnH_4, CH_4, C_2H_2, C_2H_4, and C_6H_6. Note that it is desirable to make no material gas flow from a gas introduction port to a gas discharge port by the most direct way.

[0054]

When a space surrounded by a chamber wall 11 is depressurized to 5×10^{-3} Torr (0.665 Pa) or less, preferably 1×10^{-3} Torr (0.133 Pa) or less, by a depressurizing means (a turbo molecular pump 16 or a vacuum pump such as a dry pump and a cryopump 17), and the organic compound inside is heated up to a sublimation temperature by a heating means disposed in the vapor deposition cell (resistance which is generated on the occasion that a voltage is applied (resistance heating)), it is evaporated and deposited over a surface of the substrate 10. By introducing a material gas with several sccm on the occasion of this vapor deposition, a component of the material gas is contained in a film. Note that in FIG.1, shown is such an

example that co-deposition is carried out with one cell being inclined so that an evaporated first material 15a and an evaporated second material 15b are mixed, and further, the introduced material gas is mixed to form a film. The co-deposition refers to a vapor deposition method in which different vapor deposition sources are heated and evaporated at the same time, and different materials are mixed in a film forming stage. In addition, the substrate holder 12 is rotated so that a film thickness is equalized, on the occasion of vapor deposition.

[0055]

Note that it is assumed in this specification that the surface of the substrate 10 includes the substrate and a thin film formed thereover, and here, it is assumed that an anode or a cathode is formed over the substrate.

[0056]

Note that the shutter 14 controls vapor deposition of an evaporated organic compound. In short, when the shutter is opened, it is possible to deposit an organic compound evaporated by being heated. Further, one or a plurality of other shutters (e.g., a shutter which covers a vapor deposition source during a period until sublimation from the vapor deposition source is stabilized) may be disposed between the substrate 10 and the shutter 14.

[0057]

Note that it is desirable to heat and evaporate an organic compound prior to vapor deposition so that vapor deposition can be immediately started once the shutter 14 is opened at the time of vapor deposition, since film forming time can be shortened.

[0058]

In addition, in the film forming apparatus in this invention, it becomes possible to form an organic compound film having a plurality of functional regions in

one film forming chamber, and a plurality of vapor deposition sources are disposed in accordance with it.

[0059]

In addition, disposed is an anti-attachment plate 19 for preventing an organic compound from being attached to an inner wall at the time of vapor deposition. By disposing this anti-attachment plate 19, it is possible to have an organic compound, which is not deposited on the substrate, attached.

[0060]

In addition, the film forming chamber is coupled to a plurality of vacuum exhausting processing chambers which evacuate the film forming chamber. For the vacuum exhausting processing chamber, it is equipped with a magnetic levitation type turbo molecular pump 16 and a cryopump 17. Thus, it is possible to set ultimate vacuum of the film forming chamber to 10^{-5} to 10^{-6} Pa. Note that it is designed to stop the cryopump 17 after vacuum evacuation is carried out by the cryopump 17, and to carry out vapor deposition over flowing a material gas with several sccm, while carrying out vacuum evacuation by the turbo molecular pump 16. After vapor deposition is finished, an inert gas is introduced while discharging air by the turbo molecular pump, to increase a pressure to some extent, and the remaining material gas is discharged from the film forming chamber, and high vacuum evacuation is carried out again. Finally, a deposited substrate is pulled out from the film forming chamber to a load chamber while keeping vacuum.

[0061]

In addition, as a material which is used for a chamber wall 11, since it is possible to lessen sorbability of an impurity such as oxygen and water by lessening its surface area, aluminum, stainless steel (SUS), or the like, which is made to have a

mirror surface by applying electrolytic polishing, is used for an inside wall surface. Thus, it is possible to maintain a degree of vacuum in the film forming chamber at 10^{-5} to 10^{-6} Pa. Further, a material such as ceramics, which is processed so as to have extremely fewer air holes, is used for an inside member. Note that it is preferable that these are materials having such surface smoothness that center line average asperity is 3 nm or less.

[0062]

If the film forming apparatus shown in FIG. 1 is used, it is possible to form a high-density film by intentionally introducing a material gas at the time of film formation to have a component of the material gas contained in an organic compound film. By having a component of a material gas contained in an organic compound film, it is possible to block an impurity such as oxygen and moisture, which causes deterioration, from intruding and diffusing in a film, and to improve reliability of a light emitting element.

[0063]

For example, when a monosilane gas with several sccm is introduced into a film forming chamber in which vapor deposition is performed by evaporating an organic material, together with the organic material which is evaporated from a vapor deposition source and proceeds to a substrate, SiH_4 floating in the film forming chamber is taken in an organic film. That is, a gap of organic material molecules with a relatively large particle radius is to be filled with SiH_4 with a small atomic radius as it is, or with SiHx, and it is possible to have it contained in the organic film. During a period of vapor deposition, a vapor deposition source is heated to approximately 100°C, but decomposition temperature (decomposition temperature under atmospheric pressure) of monosilane is approximately 550°C, and therefore, it is not decomposed.

Depending on an organic material to be evaporated, there is also such a case that it is reacted with SiH_4, or SiHx to form a compound. In addition, since oxygen (or moisture), which slightly remains in the film forming chamber, is captured to generate SiOx, it is possible to reduce oxygen (or moisture) which is a factor for deteriorating an organic material in the film forming chamber and in a film, and accordingly, it is possible to improve reliability of a light emitting element. In addition, generated SiOx may be contained in a film as it is.

[0064]

It is conceivable that when there is a gap of organic material molecules in a film, it is easy for oxygen to enter into the gap, and deterioration is generated. Therefore, since it is only necessary that this gap is filled, it is possible to improve reliability of a light emitting element even by using SiF_4, GeH_4, GeF_4, SnH_4, or a hydro carbon series gas (CH_4, C_2H_2, C_2H_4, C_6H_6, or the like).

[0065]

Note that as the above-described organic material, it is possible to cite α-NPD(4,4'-bis-[*N*-(naphthyl)-*N*-phenyl-amino]biphenyl), BCP(basocuproine), MTDATA(4,4',4"-tris(*N*-3-metylphenyl-*N*-phenyl-amino)triphenylamine), Alq_3(tris-8-quinolinoaluminum complex), and the like.

[0066]

Hereinafter, by use of the film forming apparatus of FIG. 1, shown is one example of a fabricating procedure of a light emitting element having an anode, an organic compound layer which is in contact with the anode, and a cathode which is in contact with the organic compound layer.

[0067]

Firstly, a substrate, over which an anode is formed, is carried in a carry-in

chamber (not shown). As a material which forms the anode, a transparent conductive material is used, and it is possible to use an indium/tin compound, zinc oxide, or the like. Then, it is transported to a film formation pretreatment chamber (not shown) coupled to the carry-in chamber (not shown). In this film formation pretreatment chamber, cleaning of an anode surface, oxidation treatment, heat treatment, and the like may be carried out. For the cleaning of the anode surface, irradiation of ultraviolet rays is carried out in vacuum, and the anode surface is cleaned. In addition, for the oxidation treatment, it may be irradiated with ultraviolet rays in an atmosphere containing oxygen while being heated at 100 to 120°C, and it is useful to such a case that the anode is an oxide like ITO. In addition, for the heat treatment, heating at a heat temperature of 50°C or more, at which a substrate is sustainable in vacuum, preferably, heating at 65 to 150°C may be carried out, and removed is an impurity such as oxygen and moisture attached to the substrate, and an impurity such as oxygen and moisture in a film formed over the substrate. In particular, since an EL material is easily deteriorated by an impurity such as oxygen and water, it is useful to heat in vacuum prior to vapor deposition.

[0068]

Then, the substrate, for which the above-described pretreatment is finished, is carried in the film forming chamber without being exposed to atmospheric air. In the film forming chamber, the substrate 10 is set with a surface on which a film is to be formed facing downward. Note that it is preferable that the film forming chamber be evacuated before the substrate is carried in.

[0069]

A vacuum exhausting means which is disposed so as to be coupled to the film forming chamber evacuates to a pressure approximately 1 Pa lower than an

atmospheric pressure by an oil-free dry pump, and evacuates to a pressure lower than that by the magnetic levitation type turbo molecular pump 16. Further, in the film forming chamber, for the purpose of removing moisture, the cryopump 17 is disposed as well. Thus, a degree of vacuum up to 1×10^{-6} Torr is realized.

[0070]

On the occasion of evacuating the film forming chamber, it is possible to remove adsorbed water and adsorbed oxygen which are attached to a film forming chamber inner wall, a metal mask, an anti-attachment shield, and the like at the same time. Further, it is preferable that the film forming chamber is heated before the substrate is carried in. After the substrate heated in the pretreatment is cooled slowly and carried in the film forming chamber, it is heated again, which takes a long time and invites lowering of throughput. Desirably, the substrate heated by heat treatment carried out in the pretreatment is carried in and set in the heated film forming chamber as it is without being cooled. Note that since a heating means for heating the substrate is disposed in the substrate holder 12 in the apparatus shown in FIG. 1, it is also possible to carry out heat treatment in vacuum, which is the pretreatment, in the film forming chamber.

[0071]

Here, heat treatment in vacuum (anneal) is carried out in the film forming chamber before vapor deposition is carried out. By this anneal (deairing), removed are an impurity such as oxygen and moisture, which is attached to the substrate, and an impurity such as oxygen and moisture in a film formed over the substrate. In order to remove the impurity, which has been removed in this manner, from the film forming chamber, it is preferable to carry out vacuum evacuation, and further, a degree of vacuum may be heightened.

[0072]

Then, vapor deposition is carried out in the film forming chamber evacuated up to a degree of vacuum of 5×10^{-3} Torr (0.665 Pa) or less, preferably 10^{-4} to 10^{-6} Torr, over introducing a material gas with several sccm. On the occasion of vapor deposition, a first organic compound has been evaporated by resistance heating in advance, and diffuses in a direction of the substrate 10 by the shutter 14 opened at the time of vapor deposition. The evaporated organic compound diffuses upward, is mixed with a material gas, and is deposited on the substrate 10, passing through an opening part (not shown) which is formed in a metal mask. Note that on the occasion of vapor deposition, a temperature of the substrate is set to 50 to 200°C, preferably 65 to 150°C, by a means for heating the substrate.

[0073]

In the apparatus shown in FIG. 1, a heating means for heating the substrate is disposed, and heat treatment in vacuum is carried out during a period of film formation. Since there is such a fear that an impurity such as oxygen and moisture is mixed in an evaporation material at the time of vapor deposition, it is useful to carry out heat treatment in vacuum during a period of vapor deposition to discharge a gas contained in a film. In this manner, by carrying out vapor deposition over heating the substrate in vacuum and forming a film with a desired film thickness, it is possible to form a high-density organic compound layer. Note that an organic compound, which is mentioned here, is an organic compound which has a property such as a hole injection property for accepting a hole from an anode, a hole transport property in which hole mobility is higher than electron mobility, an electron transport property in which electron mobility is higher than hole mobility, an electron injection property for accepting an electron from a cathode, a blocking property for blocking a move of a

hole or an electron, and a light emission property for showing light emission.

[0074]

In this manner, vapor deposition of an organic compound is finished, and a film, which is composed of the organic compound, is formed over an anode.

[0075]

Further, in order to reduce an impurity such as moisture and oxygen in the obtained organic compound layer, heat treatment is carried out at a pressure of 1×10^{-4} Torr or less, and heat treatment for discharging moisture or the like mixed in at the time of vapor deposition may be carried out. Since there is such a fear that an impurity such as oxygen and moisture is mixed in an evaporation material at the time of vapor deposition, it is useful to carry out heat treatment in vacuum after vapor deposition to discharge a gas contained in a film. In case of carrying out anneal after vapor deposition, it is preferable to carry the substrate in a processing chamber which is different from the film forming chamber, without it exposed to atmospheric air, and carry out anneal in vacuum.

[0076]

Since the heating means for heating the substrate is disposed in the apparatus shown in FIG. 1, it is also possible to carry out heat treatment in vacuum in the film forming chamber after film formation. It is preferable to carry out anneal at 100 to 200°C, after vapor deposition, in further higher vacuum than a degree of vacuum on the occasion of vapor deposition. By this anneal (deairing) after film formation, an impurity such as oxygen and moisture in an organic compound layer formed over the substrate is further removed, and a high-density organic compound layer is formed.

[0077]

In the organic compound layer, in the case of introducing a material gas or a

main component of the material gas, for example, a monosilane gas on the occasion of vapor deposition, silicon of 0.01 atoms% to 5 atoms%, preferably approximately 1 atoms% to 2 atoms%, by SIMS measurement, is designed to be contained. Since a film containing an organic compound formed as a film by use of the film forming apparatus shown in FIG. 1 becomes a film containing a material gas or a main component of the material gas and in which oxygen and moisture are hard to be taken, improved is reliability of a light emitting element which uses this film containing an organic compound.

[0078]

The processes indicated up to here are of a case of forming a single layer of an organic compound.

[0079]

Hereinafter, by repeating the above-described forming processes of a single layer, a desired organic compound layer is laminated, and finally, a cathode is formed as a laminated layer. Note that in case of laminating different evaporation materials (an organic compound and a material of a cathode), they may be laminated in separate film forming chambers, or all may be laminated in the same film forming chamber. As a material of a cathode, a material containing magnesium (Mg), lithium (Li), or calcium (Ca), in which a work function is small, is used. Preferably, an electrode, which contains MgAg (a material in which Mg and Ag are mixed at Mg : Ag = 10 : 1) may be used. Besides, cited are ytterbium (Yb), MgAgAl electrodes, LiAl electrodes, and LiFAl electrodes. In this manner, it is possible to fabricate a light emitting element which has an anode, an organic compound layer which is in contact with the anode, and a cathode which is in contact with the organic compound layer. In addition, it is possible to carry out anneal before film formation, in a film forming

chamber, and in that case, throughput is improved. Further, it is possible to carry out anneal after film formation, and in that case, throughput is improved.

[0080]

(Embodiment Mode 2)

Here, a film forming apparatus, which is different from that of Embodiment Mode 1, is shown in FIG. 2.

[0081]

FIG. 2 shows an example of a film forming apparatus in which a vapor deposition source is moved (or rotated) so that a film is formed uniformly.

[0082]

In FIG. 2, 20 designates a substrate, 21 designates a chamber wall, 22 designates a substrate holder, 23 designates a cell, 25a designates an evaporated first material, 25b designates an evaporated second material, 26 designates a turbo molecular pump, 27 designates a cryopump, and 28 designates a moving mechanism for moving the cell. Since there is no necessity to rotate the substrate, it is possible to provide a vapor deposition apparatus which can correspond to a large area substrate. In addition, by the vapor deposition cell 23 moving in an X axis direction and a Y axis direction to the substrate, it becomes possible to form a vapor deposition film uniformly.

[0083]

In the vapor deposition apparatus of this invention, on the occasion of vapor deposition, a spacing distance *d* of the substrate 20 and the vapor deposition cell 23 is narrowed to typically 30 cm or less, preferably 20 cm or less, more preferably 5 cm to 15 cm to dramatically improve utilization efficiency of a vapor deposition material and throughput.

[0084]

Further, there is not such a necessity that an organic compound which is provided on the vapor deposition cell 23 is one or of one type, and a plurality of organic compounds may be provided. For example, in addition to a material of one type, which is provided in the vapor deposition source holder as a luminescent organic compound, another organic material (dopant material) which can become a dopant may be provided all together. It is preferable that an organic compound layer to be deposited be configured with a host material and a luminescent material (dopant material) whose excitation energy is lower than that of the host material and it be designed in such a manner that excitation energy of a dopant becomes lower than excitation energy of a hole transport property region, and excitation energy of an electron transport layer. Thus, it is possible to prevent diffusion of molecular exciters of the dopant to have the dopant emit light effectively. In addition, if the dopant is a carrier-trap type material, it is also possible to heighten recombination efficiency of a carrier. Further, such a case that a material which can convert triplet excitation energy into light emission is added to a mixed region as a dopant is assumed to be included in this invention. In addition, in forming the mixed region, concentration gradient may be applied to the mixed region.

[0085]

Further, in the case of using a plurality of organic compounds which are provided in one vapor deposition source holder, it is desirable that an evaporating direction be tilted so as to be crossed at a position of a material to be deposited, so that the organic compounds are mixed with each other. In addition, for the purpose of carrying out co-deposition, in the vapor deposition cell, four kinds of vapor deposition materials (e.g., as a deposition material a, two kinds of host materials, and as a

deposition material b, two kinds of dopant materials) may be provided.

[0086]

Further, in the case of citing a major process in which there is such a fear that an impurity such as oxygen and water is mixed in an EL material and a metal material, which are to be deposited, a process for setting an EL material in a film forming chamber prior to vapor deposition, a vapor deposition process, and the like are conceivable.

[0087]

Thus, it is preferable to provide a glove in a pretreatment chamber coupled to a film forming chamber, move a vapor deposition source in its entirety from the film forming chamber to the pretreatment chamber, and set a vapor deposition material in the vapor deposition source in the pretreatment chamber. That is, designed is a manufacturing apparatus in which a deposition source is moved up to the pretreatment chamber. Thus, it is possible to set a vapor deposition source, while maintaining a cleaning level of the film forming chamber.

[0088]

Also in the film forming apparatus shown in FIG. 2, by intentionally introducing a material gas at the time of film formation to have a component of the material gas contained in an organic compound film, it is possible to make a high-density film. By having a component of the material gas contained in the organic compound film, it is possible to block an impurity such as oxygen and moisture, which causes deterioration, from intruding and diffusing in a film, and to improve reliability of a light emitting element.

[0089]

Further, it is possible to freely combine this embodiment mode with

Embodiment Mode 1.

[0090]

(Embodiment Mode 3)

Here, a film forming apparatus which is different from that of the embodiment mode 1 is shown in FIG. 3. Note that the same reference numerals are used for the same places as those in FIG. 1.

[0091]

The film forming apparatus shown in FIG. 3 is an example in which vapor deposition is carried out over introducing a material gas radicalized by a plasma generating means in advance into a film forming chamber.

[0092]

As shown in FIG. 3, a microwave source 30a is connected to a waveguide 30b. This waveguide 30b forms plasma 30c due to glow discharge, by carrying out irradiation to a material gas in a discharge tube. From the microwave source which is used here, a μ wave of approximately 2.45 GHz is radiated.

[0093]

For example, in the case where a monosilane gas is used as a material gas, an oxide silicon precursor such as SiHx, SiHxOy, or SiOy is generated and introduced into a film forming chamber. These radicals are easily reacted with oxygen and moisture and thus it is possible to reduce oxygen concentration and a moisture amount in the film forming chamber, so that it is possible to obtain an organic compound film with high reliability.

[0094]

In addition, since these radicals are easily moved to or deposited at a place with higher temperature, it is preferable to carry out vapor deposition over heating a

substrate by a heater 31 which is disposed in the substrate holder 12. In addition, for the purpose of preventing them from being moved to or deposited on the vapor deposition cell 13, it is preferable to cover the vapor deposition cell 13 by a heat insulating material.

[0095]

Further, it is possible to freely combine this embodiment mode with Embodiment Mode 1 or Embodiment Mode 2.

[0096]

(Embodiment Mode 4)

Here, a film forming apparatus which is different from that of Embodiment Mode 1 is shown in FIG. 4.

[0097]

The film forming apparatus shown in FIG. 4 is an example in which, by using an ion plating method, a material gas is ionized in a film forming chamber and attached to an evaporated organic material 65, and along with it, vapor deposition is carried out.

[0098]

In FIG. 4, 60 designates a substrate, 61 designates a chamber wall, 62 designates a substrate holder, 63 designates a cell, 65 designates an evaporated organic material, 66 designates a turbo molecular pump, 67 designates a cryopump, 68 designates a level block, and 69 designates an anti-attachment plate.

[0099]

In the film forming apparatus shown in FIG. 4, disposed are an electron gun 50 for irradiating a crucible 52 which accommodates a material 51 with an electron beam, and a plasma generating means 64 for generating plasma 53.

[0100]

The crucible 52 is irradiated with an electron beam by the electron gun 50 to melt and evaporate the material 51 in the crucible so that an evaporation flow of the material 51 is formed and ionized by the plasma generating means 64, the ionized evaporation flow and the organic material 65 evaporated from the vapor deposition cell 63 are mixed, and by bombarding these against the substrate, a film is formed.

[0101]

In the film forming apparatus shown in FIG. 4, the material 51 evaporated in the midstream of vapor deposition of an organic material is chemically attached, and a component of the material 51 is contained in an organic compound film, and thereby, it is possible to make a high-density film. By having a component of a material 51 contained in the organic compound film, it is possible to block an impurity such as oxygen and moisture, which causes deterioration, from intruding and diffusing in a film, and to improve reliability of a light emitting element.

[0102]

Further, it is possible to freely combine this embodiment mode with any one of Embodiment Modes 1 to 3.

[0103]

As to this invention having the above-described structure, it will be described in detail with embodiments described as follows.

[0104]

(Embodiments)

[Embodiment 1]

In this embodiment, described is an example of fabricating elements which have functions of a plurality of materials in the same manner as a function separation of a laminated structure, at the same time of heightening mobility of carriers by

mitigating an energy barrier which exists in an organic compound film.

[0105]

With regard to mitigation of the energy barrier in the laminated structure, it is notably seen in a technology of insertion of a carrier injection layer. In short, at an inface of a laminated structure with a large energy barrier, by inserting a material for mitigating that energy barrier, it is possible to design the energy barrier stepwise. Thus, it is possible to heighten a carrier injection property from an electrode, and indeed, to lower a drive voltage to some extent. However, a problem is that, by increasing the number of layers, the number of organic interfaces is increased conversely. This is considered to be a cause of such a fact that a single layer structure holds top data of drive voltage/power efficiency. Conversely, by overcoming this point, a merit of the laminated structure (it is possible to combine various materials, and there is no necessity of a complex molecular design) can be exploited and it is possible to catch up with the drive voltage/power efficiency of the single layer structure.

[0106]

Thus, in the case where an organic compound film which is composed of a plurality of functional regions is formed between an anode and a cathode of a light emitting element, formed is not a conventional laminated structure in which a distinct interface exists, but a structure having a mixed region which is composed of both of a material which forms a first functional region and a material which forms a second functional region, between the first functional region and the second functional region.

[0107]

By applying the above structure, it is conceivable that an energy barrier, which exists between functional regions, is reduced as compared to a conventional structure,

and an injection property of carriers is improved. That is, the energy barrier between functional regions is mitigated by forming the mixed region. Therefore, it becomes possible to prevent reduction of a drive voltage and luminance lowering.

[0108]

From the foregoing, in this embodiment, in fabrication of a light emitting element which has at least a region (first functional region) in which a first organic compound can express a function, and a region (second functional region) in which a second organic compound which is different from a substance which forms the first functional region can express a function, and a light emitting device having this, by using the film forming apparatus shown in FIG. 1, fabricated is a mixed region which is composed of an organic compound which forms the first functional region and an organic compound which forms the second functional region, between the first functional region and the second functional region.

[0109]

The film forming apparatus shown in FIG. 1 is designed so that an organic compound film which has a plurality of functional regions is formed in one film forming chamber, and a plurality of vapor deposition sources are also disposed accordingly. Note that a substrate over which an anode is formed is carried in and set.

[0110]

Firstly, a first organic compound which is provided in a first material chamber is deposited. Note that the first organic compound has been evaporated in advance by resistance heating, and diffuses in a direction of a substrate by a first shutter opened at the time of vapor deposition. On the occasion of vapor deposition, a material gas, here, a monosilane gas is introduced to be contained in a film. Thus, it is possible to form a first functional region 210 shown in FIG. 5(A).

[0111]

Then, over depositing the first organic compound 17a, a second shutter is opened, and a second organic compound which is provided in a second material chamber is deposited. Note that the second organic compound has also been evaporated in advance by resistance heating, and diffuses in a direction of the substrate by the second shutter opened at the time of vapor deposition. On the occasion of vapor deposition, a material gas, here, a monosilane gas is introduced to be contained in a film. Thus, it is possible to form a first mixed region 211 which is composed of the first organic compound and the second organic compound.

[0112]

And, after a brief interval, only the first shutter is closed, and the second organic compound is deposited. On the occasion of vapor deposition, a material gas, here, a monosilane gas is introduced to be contained in a film. Thus, it is possible to form a second functional region 212.

[0113]

Note that in this embodiment, described is a method of forming a mixed region by depositing two kinds of organic compounds at the same time, but it is also possible to form a mixed region between a first functional region and a second functional region by depositing a second organic compound in its deposition atmosphere after a first organic compound is deposited.

[0114]

Next, over depositing the second organic compound, a third shutter is opened, and a third organic compound which is provided in a third material chamber is deposited. Note that the third organic compound has also been evaporated in advance by resistance heating and diffuses in a direction of the substrate by the third shutter

opened at the time of vapor deposition. On the occasion of vapor deposition, a material gas, here, a monosilane gas is introduced to be contained in a film. Thus, it is possible to form a second mixed region 213 which is composed of the second organic compound and the third organic compound.

[0115]

Then, after a brief interval, only the second shutter is closed, and the third organic compound is deposited. On the occasion of vapor deposition, a material gas, here, a monosilane gas is introduced to be contained in a film. Then, by closing the third shutter, vapor deposition of the third organic compound is completed. Thus, it is possible to form a third functional region 214.

[0116]

Finally, by forming a cathode, a light emitting element which is formed by the film forming apparatus of this invention is completed.

[0117]

Further, for another organic compound film, as shown in FIG. 5(B), after a first functional region 220 is formed by using a first organic compound, a first mixed region 221 which is composed of the first organic compound and a second organic compound is formed, and further, by using the second organic compound, a second functional region 222 is formed. And, in the midstream of forming the second functional region 222, vapor deposition of a third organic compound 17c is carried out with a third shutter opened temporarily, and thereby, a second mixed region 223 is formed.

[0118]

After a brief interval, by closing the third shutter, the second functional region 222 is formed again. Then, by forming a cathode, a light emitting element is formed.

[0119]

Since the film forming apparatus of FIG. 1, which can form an organic compound film described above can form an organic compound film having a plurality of functional regions, in the same film forming chamber, it is possible to form a mixed region at a functional region interface. From the foregoing, it is possible to fabricate a light emitting element which does not show a clear laminated structure (i.e., there is no distinct organic interface) and has a plurality of functions.

[0120]

In addition, the film forming apparatus of FIG. 1 is capable of introducing a material gas (monosilane gas) intentionally at the time of the film formation, and having a component of the material gas contained in an organic compound film, and by having a material with a small atomic radius (typically, silicon) contained in an organic compound film, it is possible to fit more molecules in the mixed region. Therefore, further, it becomes possible to prevent reduction of a drive voltage and luminance lowering. In addition, it is also possible to remove an impurity such as oxygen and moisture in a film forming chamber by the material gas, and it is possible to form a high-density organic compound layer.

[0121]

Further, it is possible to freely combine this embodiment with Embodiment Mode 1, Embodiment Mode 2, Embodiment Mode 3, or Embodiment Mode 4.

[0122]

[Embodiment 2]

In this embodiment, an example of a multi-chamber type manufacturing apparatus, in which fabrication from a first electrode up to sealing is fully automated, is shown in FIG. 6.

[0123]

FIG. 6 shows a multi-chamber manufacturing apparatus which has gates 500a to 500y, transport chambers 502, 504a, 508, 514, and 518, hand-over chambers 505, 507, and 511, a loading chamber 501, a first film forming chamber 506H, a second film forming chamber 506B, a third film forming chamber 506G, a fourth film forming chamber 506R, a fifth film forming chamber 506E, and other film forming chambers 509, 510, 512, 513, 531, and 532, installation chambers 526R, 526G, 526B, 526E, and 526H in which vapor deposition sources are installed, pretreatment chambers 503a and 503b, a sealing chamber 516, a mask stock chamber 524, a seal substrate stock chamber 530, cassette chambers 520a and 520b, a tray mounting stage 521, and a pull-out chamber 519. Note that in the transport chamber 504a, disposed is a transport mechanism 504b for transporting a substrate 504c, and in each of other transport chambers, a transport mechanism is provided in the same manner.

[0124]

Hereinafter, a procedure for carrying a substrate, on which an anode (first electrode) and an insulator (partition wall) which covers an end part of the anode are disposed, in a manufacturing apparatus shown in FIG. 6, so that a light emitting device is fabricated is shown. Note that in the case of fabricating an active matrix light emitting device, a plurality of thin film transistors (current control TFTs) which are connected to an anode, and other thin film transistors (switching TFTs and the like) have been disposed on a substrate in advance, and a drive circuit which is composed of thin film transistors is also disposed. In addition, also in case of fabricating a simple matrix light emitting device, it can be fabricated by the manufacturing apparatus shown in FIG. 6.

[0125]

Firstly, the above-described substrate is set to the cassette chamber 520a or the cassette chamber 520b. In the case where the substrate is a large size substrate (e.g., 300 mm × 360 mm), it is set to the cassette chamber 520b, and in the case where it is a normal substrate (e.g., 127 mm × 127 mm), after it is set to the cassette chamber 520a, it is transported to the tray mounting stage 521, and a plurality of substrates are set to a tray (e.g., 300 mm × 360 mm).

[0126]

The substrate (a substrate on which an anode and an insulator which covers an end part of the anode are disposed) which is set to the cassette chamber is transported to the transport chamber 518.

[0127]

In addition, before it is set to the cassette chamber, for the purpose of reducing point defects, it is preferable to clean a surface of a first electrode (anode) by a porous sponge (typically, made of PVA (polyvinyl alcohol), made of nylon, or the like) in which a surface-active agent (alkalescent) is contained, so that dusts on the surface are removed. As a cleaning mechanism, a cleaning apparatus having a roll brush (made of PVA) which is turned around an axial line in parallel with a surface of the substrate and is in contact with the surface of the substrate may be used, or a cleaning apparatus having a disk brush (made of PVA) which is turned around an axial line perpendicular to the surface of the substrate and is in contact with a surface of the substrate may be used. In addition, prior to forming a film which contains an organic compound, in order to remove moisture and another gas which are contained in the above-described substrate, it is preferable to carry out anneal for deairing in vacuum, so it is transported to the pretreatment chamber 523 coupled to the transport chamber 518 and anneal may be carried out there.

[0128]

Then, it is transported to the loading chamber 501 from the transport chamber 518 in which a substrate transport mechanism is disposed. In the manufacturing apparatus of this embodiment, in the loading chamber 501, a substrate inverting mechanism is provided, and it is possible to invert the substrate properly. The loading chamber 501 is coupled to a vacuum exhausting processing chamber, and it is preferable that after vacuum evacuation is carried out, an inert gas is introduced to realize an atmospheric pressure.

[0129]

Then, it is transported to the transport chamber 502 coupled to the loading chamber 501. In order that moisture and oxygen do not exist in the transport chamber 502 to the utmost, it is preferable to perform vacuum evacuation in advance and maintain vacuum.

[0130]

In addition, for the above-described vacuum exhausting processing chamber, a magnetic levitation type turbo molecular pump, a cryopump, or a dry pump is provided. Thus, it is possible to set ultimate vacuum of the transport chamber coupled to the loading chamber to 10^{-5} to 10^{-6} Pa, and further, it is possible to control back diffusion of an impurity from a pump side and an air exhaust system. In order to prevent an impurity from being introduced into an apparatus, an inert gas such as nitrogen and a rare gas is used as a gas to be introduced. As these gasses which are introduced into the apparatus, used is one which is highly purified by a gas purification machine before it is introduced into an apparatus. Therefore, there is a necessity of providing a gas purification machine so that a gas is introduced into a vapor deposition apparatus after being highly purified. Thus, since it is possible to remove an impurity such as

oxygen, water, and any other impurity, which is contained in a gas, in advance, it is possible to prevent these impurities from being introduced into the apparatus.

[0131]

In addition, in the case where it is desired to remove a film containing an organic compound, which is formed at an unnecessary place, it may be transported to the pretreatment chamber 503a to selectively remove a laminated layer of organic compound films. The pretreatment chamber 503a has a plasma generating means, and plasma is generated by exciting one kind or a plurality kinds of gasses selected from Ar, H, F, and O, thereby dry etching is carried out. In addition, a UV irradiating mechanism may be disposed in the pretreatment chamber 503a so that ultraviolet ray irradiation can be carried out as anode surface treatment.

[0132]

In addition, in order to eliminate shrink, it is preferable to carry out vacuum heating right before vapor deposition of a film which contains an organic compound, and it is transported to the pretreatment chamber 503b, and in order to completely remove moisture and any other gas which are contained in the above-described substrate, anneal for deairing is carried out in vacuum (5×10^{-3} Torr (0.665 Pa) or less, preferably 10^{-4} to 10^{-6} Pa). In the pretreatment chamber 503b, by using a flat plate heater (typically, a sheath heater), a plurality of substrates are heated uniformly. In particular, in the case where an organic resin film is used as a material of an interlayer insulating film and a partition wall, since there is such a fear that depending on an organic resin material, it adsorbs moisture easily, and further, degasification is caused, it is useful to carry out vacuum heating for removing adsorbed moisture by carrying out natural cooling for 30 minutes, after heating, for example, 30 minutes or more is carried out at 100°C to 250°C, preferably 150°C to 200°C before a layer containing an

organic compound is formed.

[0133]

Then, after the above-described vacuum heating is carried out, the substrate is transported from the transport chamber 502 to the hand-over chamber 505, and further, the substrate is transported from the hand-over chamber 505 to the transport chamber 504a without being exposed to atmospheric air.

[0134]

After that, the substrate is properly transported to the film forming chambers 506R, 506G, 506B, and 506E, which are coupled to the transport chamber 504a, and formed properly is an organic compound layer which is formed of low molecules which become a hole injection layer, a hole transport layer, a light emitting layer, an electron transport layer, or an electron injection layer. In addition, it is also possible to transport the substrate from the transport chamber 502 to the film forming chamber 506H to carry out deposition.

[0135]

In addition, in the film forming chamber 512, a hole injection layer which is composed of a polymeric material, may be formed by an ink-jet method and a spin coating method. In addition, the substrate is placed vertically, and a film may be formed by an ink-jet method in vacuum. Over a first electrode (anode), a poly(ethylene dioxythiophene)/poly(styrene sulfonic acid) aqueous solution (PEDOT/PSS), a polyaniline/camphorsulfonic acid aqueous solution (PANI/CSA), PTPDES, Et-PTPDEK, PPBA or the like which acts as a hole injection layer (anode buffer layer) may be applied to an entire surface and baked. Baking is preferably carried out in a bake chamber 123. In the case where a hole injection layer which is composed of a polymeric material is formed by an application method using a spin

coat and the like, planarity is improved and it is possible to make coverage and film thickness uniformity of a film to be formed on it better. In particular, since a film thickness of a light emitting layer becomes uniform, it is possible to obtain uniform light emission. In this case, it is preferable that after the hole injection layer is formed by the application method, right before film formation by a vapor deposition method, vacuum heating (100 to 200°C) be carried out. Vacuum heating may be carried out in the pretreatment chamber 503b. For example, a surface of a first electrode (anode) is cleaned by a sponge, it is transported to the cassette chamber and transported to the film forming chamber 512, poly(ethylene dioxythiophene)/poly(styrene sulfonic acid) aqueous solution (PEDOT/PSS) is applied to an entire surface to a film thickness of 60 nm by a spin coating method, and thereafter, it is transported to the bake chamber 523 and tentatively baked at 80°C for 10 minutes and really baked at 200°C for an hour, and further, it is transported to the pretreatment chamber 503b and vacuum heating (170°C , heating for 30 minutes, and cooling for 30 minutes) is carried out right before vapor deposition, and thereafter, it is transported to the film forming chambers 506R, 506G, and 506B, and a light emitting layer may be formed by a vapor deposition method without being exposed to atmospheric air. In particular, in the case where an ITO film is used as an anode material, and concavity and convexity and minute particles exist on a surface, by setting a film thickness of PEDOT/PSS to a film thickness of 30 nm or more, it is possible to reduce influence of them.

[0136]

In addition, when PEDOT/PSS is applied to the ITO film, wettability of PEDOT/PSS is not so good; therefore, it is preferable to improve the wettability by carrying out cleaning with purified water once after first time application of the PEDOT/PSS aqueous solution is carried out by a spin coating method, to carry out

second time application of the PEDOT/PSS aqueous solution by a spin coating method, and to carry out baking so as to form a film with good uniformity. Note that by carrying out cleaning with purified water once after the first time application is carried out, obtained is such an advantage that a surface is modified and minute particles and the like can be removed.

[0137]

In addition, in the case where PEDOT/PSS is formed as a film by a spin coating method, since the film is formed over an entire surface, it is preferable to selectively remove an end surface and a peripheral part of a substrate, a terminal part, a connection region of a cathode and a lower part wiring, and the like, and it is preferable to remove them by O_2 ashing in the pretreatment chamber 503a.

[0138]

Here, the film forming chambers 506R, 506G, 506B, 506E, and 506H will be described.

[0139]

In each film forming chamber 506R, 506G, 506B, 506E, or 506H, a movable vapor deposition source holder (vapor deposition cell) is installed. That is, it corresponds to the film forming chamber of Embodiment Mode 2, which is shown in FIG. 2. As described in Embodiment Mode 2, vapor deposition is carried out over introducing a material gas on the occasion of vapor deposition. As the material gas, concretely speaking, one kind or a plurality of kinds selected from a silane series gas (monosilane, disilane, trisilane, or the like), SiF_4, GeH_4, GeF_4, SnH_4, and a hydro carbon series gas (CH_4, C_2H_2, C_2H_4, C_6H_6, or the like) may be used. By intentionally introducing a material gas at the time of film formation to have a component of the material gas contained in an organic compound film, it is possible to make a

high-density film. By having a component of a material gas contained in an organic compound film, it is possible to block an impurity such as oxygen and moisture, which causes deterioration, from intruding and diffusing in a film, and to improve reliability of a light emitting element.

[0140]

Note that a plurality of the deposition source holders are prepared, a plurality of containers (crucibles) in which EL materials are sealed are properly provided, and they are disposed in the film forming chamber in this state. By setting a substrate by a face-down system, carrying out positional alignment of a vapor deposition mask by CCD or the like, and carrying out deposition by a resistance heating method, it is possible to carry out film formation selectively. Note that a deposition mask is stocked in the mask stock chamber 524 and appropriately transported to the film forming chamber on the occasion of carrying out vapor deposition. In addition, the film forming chamber 532 is an auxiliary deposition chamber for forming a layer containing an organic compound and a metal material layer.

[0141]

For installation of EL materials in these film forming chambers, it is preferable to use a manufacturing system which is hereinafter described. That is, it is preferable to carry out film formation by using a container (typically, a crucible) in which an EL material has been accommodated in advance by a material maker. Further, it is preferable that the EL material be installed without being exposed to atmospheric air, and on the occasion that it is transported from a material maker, it is preferably introduced into the film forming chamber while the crucible is sealed hermetically in a second container. Desirably, the installation chambers 526R, 526G, 526B, 526H, and 526E, which have vacuum exhausting means coupled to film forming

chambers 506R, 506G, 506B, 506H, and 506E respectively are made to be in vacuum or inert gas atmosphere, and in this, the crucible is pulled out from the second container, and the crucible is installed in the film forming chamber. Note that one example of the installation chamber is shown in FIG. 7 or FIG. 8.

[0142]

Here, a figuration of a container for transporting will be concretely described by use of FIG. 7(A). The second container which is used for transport and divided into a upper part (721a) and a lower part (721b) has a fixing means 706 for fixing the first container disposed on the upper part of the second container, a spring 705 for pressurizing the fixing means, a gas feed port 708 disposed on the lower part of the second container and which becomes a gas path for reducing and maintaining pressure of the second container, an O ring for fixing a upper part container 721a and a lower part container 721b, and a fastener 702. In this second container, installed is the first container 701 in which a purified vapor deposition material is sealed. Note that the second container may be formed of a material containing stainless steel and the first container 701 may be formed of a material containing titanium.

[0143]

In a material maker, the purified vapor deposition material is sealed in the first container 701. Then, the second upper part 721a and lower part 721b are matched through the O ring 707, the upper part container 721a and the lower part container 721b are fixed by the fastener 702, and the first container 701 is sealed hermetically in the second container. After that, through the gas feed port 708, pressure in the second container is reduced, and further, atmosphere in the second container is replaced by nitrogen atmosphere, and the spring 705 is adjusted so that the first container 705 is fixed by the fixing means 706. Note that a drying agent may be disposed in the

second container. In this manner, when the second container is held in vacuum, at reduced pressure, and in nitrogen atmosphere, it is possible to prevent even attachment of slight oxygen and water to the vapor deposition material.

[0144]

In this state, it is transported to a light emitting device maker, and the first container 701 is installed in a vapor deposition chamber. After that, by heating, a vapor deposition material is sublimated, and film formation of a deposition film is carried out.

[0145]

In addition, it is preferable that other components, e.g., a film thickness monitor (a crystal oscillator or the like), a shutter, and the like be transported in the same manner without being exposed to atmospheric air and installed in a deposition apparatus.

[0146]

In addition, an installation chamber for taking out the crucible (filled with a vapor deposition material) which is vacuum-sealed in the container without being exposed to atmospheric air and for setting the crucible to a deposition holder is coupled to a film forming chamber, and the crucible is transported from the installation chamber by a transport robot without being exposed to atmospheric air. It is preferable that a vacuum exhausting means be also disposed in the installation chamber, and further, a means for heating the crucible be also disposed.

[0147]

By use of FIG. 7(A) and FIG. 7(B), a mechanism of installing the first container 701 which is sealed hermetically in the second containers 721a and 721b and transported, in the film forming chamber, will be described.

[0148]

FIG. 7(A) shows a cross-section surface of the installation chamber 705 which has a rotation table 707 on which the second containers 721a and 721b, in which the first container is accommodated, are mounted, a transport mechanism for transporting the first container, and a lift mechanism 711. In addition, the installation chamber is allocated so as to be adjacent to the film forming chamber, and it is possible to control atmosphere of the installation chamber by a means for controlling atmosphere through the gas feed port. Note that the transport mechanism is not limited to such a structure that the first container is sandwiched (pinched) from an upper side of the first container 701 as shown in FIG. 7(B), and may be of such a structure that the first container is transported by sandwiching side surfaces thereof.

[0149]

In the above installation chamber, in such a state that the fastener 702 is released, the second container is allocated over a rotational installation table 713. Since an inside is in a vacuum state, even if the fastener 702 is released, it does not move. Then, by the means for controlling atmosphere, an inside of the installation chamber is made to be in a reduced pressure state. When a pressure in the installation chamber and a pressure in the second container are equal, it becomes such a state that a seal of the second container can be easily broken. And, by the lift mechanism 711, the upper part 721a of the second container is dismounted, and the rotational installation table 713 is rotated around a rotation axis 712 as an axis and thereby, the lower part of the second container and the first container are moved. Then, the first container 701 is transported to the deposition chamber by the transport mechanism, and the first container 701 is installed on a vapor deposition source holder (not shown).

[0150]

After that, by a heating means disposed in the vapor deposition source holder, a vapor deposition material is sublimated, and film formation is initiated. At the time of this film formation, when a shutter (not shown) which is disposed in the vapor deposition source holder is opened, the sublimed vapor deposition material diffusesin a direction of the substrate and is deposited over the substrate, and a light emitting layer (including a hole transport layer, a hole injection layer, an electron transport layer, and an electron injection layer) is formed.

[0151]

After vapor deposition is completed, the first container is lifted from the vapor deposition source holder, transported to the installation chamber, mounted over the lower part container (not shown) of the second container placed over a rotation table 804, and sealed hermetically by the upper part container 721a. At this time, it is preferable to seal the first container, the upper part container, and the lower part container hermetically, by a transported combination. In this state, the installation chamber 805 is made to be at atmospheric pressure, the second container is pulled out from the installation chamber and transported to a material maker with the fastener 702 fixed.

[0152]

In addition, an example of an installation chamber in which a plurality of first containers 911 can be installed is shown in FIGS. 8. In FIG. 8(A), the installation chamber 905 has a rotation table 907 on which a plurality of the first containers 911 or second containers 912 can be mouted, a transport mechanism 902b for transporting the first container, and a lift mechanism 902a, and a film forming chamber 906 has a vapor deposition source holder 903 and a mechanism (not shown here) for moving a deposition holder. FIG. 8(A) shows a top view, and FIG. 8(B) shows a perspective

view of an inside of the installation chamber. In addition, the installation chamber 905 is placed through a gate valve 900 so as to be adjacent to the film forming chamber 906, and it is possible to control atmosphere of the installation chamber by a means for controlling atmosphere through a gas feed port. Note that although not shown, a place in which an upper part (second container) 912, which is dismounted, is placed is disposed separately.

[0153]

Alternatively, it may be designed in such a manner that a robot is provided in a pretreatment chamber (installation chamber) which is coupled to the film forming chamber, and a vapor deposition source in its entirety is moved from the film forming chamber to the pretreatment chamber, and in the pretreatment chamber, a vapor deposition material is set to the vapor deposition source. That is, it may be designed as a manufacturing apparatus in which a vapor deposition source is moved up to the pretreatment chamber. Thus, it is possible to set the vapor deposition source with a cleaning degree of the film forming chamber maintained.

[0154]

Thus, it is possible to prevent a crucible and an EL material accommodated in the crucible from being contaminated. Note that in the installation chambers 526R, 526G, 526B, 528H, or 526E, a metal mask can be stocked.

[0155]

By properly selecting EL materials which are placed in the film forming chambers 506R, 506G, 506B, 506H, and 506E, as an entire light emitting element, it is possible to form a light emitting element which shows light emission of a single color (concretely, a white color) or full color (concretely, a red color, a green color, and a blue color). For example, in the case of forming a green color light emitting element,

if a cathode is formed after a hole transport layer or a hole injection layer in the film forming chamber 506H, a light emitting layer (G) in the film forming chamber 506G, and an electron transport layer or an electron injection layer in the film forming chamber 506E are sequentially laminated, it is possible to obtain the green color light emitting element. For example, in case of forming a full color light emitting element, if a cathode is formed after a hole transport layer or a hole injection layer, a light emitting layer (R), and an electron transport layer or an electron injection layer are sequentially laminated using a vapor deposition mask for R in the film forming chamber 506R; a hole transport layer or a hole injection layer, a light emitting layer (G), an electron transport layer or an electron injection layer are sequentially laminated using a vapor deposition mask for G in the film forming chamber 506G; and a hole transport layer or a hole injection layer, a light emitting layer (B), an electron transport layer or an electron injection layer are sequentially laminated using a deposition mask for B in the film forming chamber 506B, it is possible to obtain the full color light emitting element.

[0156]

Note that an organic compound layer for showing light emission of a white color is, in the case of laminating light emitting layers having different light emission colors, roughly classified into a three wavelength type which includes three primary colors of a red color, a green color, and a blue color, and a two wavelength type which uses a relation of complementary colors of a blue color/a yellow color, or a blue-green color/an orange color. It is possible to form a white color light emitting element in one film forming chamber. For example, in the case of obtaining the white color light emitting element using the three wavelength type, prepared is a film forming chamber in which provided are a plurality of deposition source holders on which a plurality of

crucibles are mounted, aromatic diamine (TPD) is sealed in a first vapor deposition source holder, p-EtTAZ is sealed in a second vapor deposition source holder, Alq_3 is sealed in a third vapor deposition source holder, an EL material in which NileRed which is a red color light emitting pigment is added to Alq_3 in a fourth vapor deposition source holder, and Alq_3 is sealed in a fifth vapor deposition source holder, and in this state, they are installed in each film chamber. And, the first through fifth vapor deposition source holders start moving in sequence, and carry out vapor deposition to a substrate, and lamination of layers. Concretely speaking, TPD is sublimated from the first vapor deposition source holder by heating, and deposited on an entire surface of the substrate. After that, p-EtTAZ is sublimated from the second vapor deposition source holder, Alq_3 is sublimated from the third vapor deposition source holder, Alq_3:NileRed is sublimated from the fourth vapor deposition source holder, Alq_3 is sublimated from the fifth vapor deposition source holder, and they are deposited on an entire surface of the substrate. After that, if a cathode is formed, it is possible to obtain the white color light emitting element.

[0157]

By the above-described process, after layers containing organic compounds are laminated as layers properly, the substrate is transported from the transport chamber 504 to the hand-over chamber 507, and further, the substrate is transported from the hand-over chamber 507 to the transport chamber 508 without being exposed to atmospheric air.

[0158]

Then, by the transport mechanism which is disposed in the transport chamber 508, the substrate is transported to the film forming chamber 510, and a cathode is formed. This cathode is a metal film (an alloy such as MgAg, MgIn, CaF_2, LiF, or

CaN, or a film formed by a co-deposition method of an element which belongs to Group 1 or Group 2 of the periodic table and aluminum, or a laminated film of these) which is formed by a vapor deposition method using resistance heating. Alternatively, a cathode may be formed by using a sputtering method.

[0159]

In addition, in the case of fabricating a top emission light emitting device, it is preferable that a cathode be transparent or semi-transparent, and it is preferable that a thin film (1 nm to 10 nm) of the above-described metal film, or a laminated layer of a thin film (1 nm to 10 nm) of the above-described metal film and a transparent conductive film be used as the cathode. In this case, by using the sputtering method, a film which is composed of a transparent conductive film (ITO (indium oxide-tin oxide alloy), an indium oxide-zinc oxide alloy (In_2O_3-ZnO), and zinc oxide (ZnO), or the like) may be formed in the film forming chamber 509.

[0160]

By the above-described process, a light emitting element of a laminated structure is formed.

[0161]

In addition, it may be designed that it is transported to the film forming chamber 513 coupled to the transport chamber 508, and a protective film which is composed of a silicon nitride film or a silicon nitride oxide film is formed for sealing. Here, in the film forming chamber 513, a target which is composed of silicon, a target which is composed of silicon oxide, or a target which is composed of silicon nitride is provided. For example, using the target which is composed of silicon, by changing film forming chamber atmosphere to nitrogen atmosphere or atmosphere containing nitrogen and argon, it is possible to form a silicon nitride film on a cathode.

Alternatively, it may be formed by use of a thin film in which a major component is carbon (a DLC film, a CN film, or an amorphous carbon film) as a protective film, and a film forming chamber using a CVD method may be disposed separately. A diamond like carbon film (also called a DLC film) can be formed by a plasma CVD method (typically, an RF plasma CVD method, a microwave CVD method, an electron cyclone resonance (ECR) CVD method, a heat filament CVD method, or the like), a combustion-flame method, a sputtering method, an ion beam deposition method, a laser deposition method, or the like. As a reactive gas which is used for film formation, used are a hydrogen gas and a carbon hydride series gas (e.g., CH_4, C_2H_2, C_2H_6, or the like), it is ionized by glow discharge, and ions are accelerated and bombarded to a cathode to which a negative self bias is applied, so that a film is formed. In addition, the CN film may be formed by using a C_2H_4 gas and a N_2 gas as a reactive gas. Note that the DLC film and the CN film are insulating films which are transparent or semi-transparent to visible light. To be transparent to visible light means that a transmission factor of visible light is 80 to 100%, and to be semi-transparent to visible light means that a transmission factor of visible light is 50 to 80%.

[0162]

In this embodiment, on a cathode, a protective layer composed of a laminated layer of a first inorganic insulating film, a stress relaxing film, and a second inorganic insulating film is formed. For example, it may be designed that after the cathode is formed, it is transported to the film forming chamber 513 to form the first inorganic insulating film, it is transported to the film forming chamber 132 to form the stress relaxing film (a layer containing an organic compound, or the like) which has a hygroscopic property and transparency by a vapor deposition method, and further, it is

transported again to the film forming chamber 513 to form the second inorganic insulating film.

[0163]

Then, the substrate over which a light emitting element is formed is transported from the transport chamber 508 to the hand-over chamber 511, without being exposed to atmospheric air, and further, transported from the hand-over chamber 511 to the transport chamber 514. Then, the substrate over which a light emitting element is formed is transported from the transport chamber 514 to the sealing chamber 516.

[0164]

A seal substrate is set from outside to the load chamber 517 and prepared. Note that in order to remove an impurity such as moisture, it is preferable to carry out anneal in advance in vacuum. And, in the case of forming a seal member for attaching the substrate on which a light emitting element is formed to the seal substrate, the seal member is formed in the sealing chamber, and the seal substrate on which the seal member is formed is transported to the seal substrate stock chamber 530. Note that in the sealing chamber, a drying agent may be disposed over the seal substrate. Note that here, an example in which the seal member is formed over the seal substrate is shown, but in particular, it is not restrictive, and the seal member may be formed over the substrate on which a light emitting element is formed.

[0165]

Then, the sealing chamber 516, the substrate and the seal substrate are attached together, and a pair of the attached substrates are irradiated with UV rays by an ultraviolet ray irradiating mechanism disposed in the sealing chamber 516 to cure the seal member. Note that here, as the seal member, an ultraviolet ray cured resin is

used, but it is not particularly restrictive as long as it is an adhesive agent.

[0166]

Then, the pair of attached substrates are transported from the sealing chamber 516 to the transport chamber 514, and then, from the transport chamber 514 to the pull-out chamber 519, and then, pulled out.

[0167]

As above, by using the manufacturing apparatus shown in FIG. 6, until a light emitting element is completely sealed in a hermetically enclosed space, it can be prevented from being exposed to atmospheric air, and therefore, it becomes possible to fabricate a light emitting device with high reliability. Note that in the transport chambers 514 and 518, vacuum and nitrogen atmosphere under atmospheric pressure are repeated, but, it is desired that vacuum be maintained on a steady basis in the transport chambers 502, 504a, and 508.

[0168]

Note that although not shown here, disposed is a control control apparatus for realizing automation by controlling a path through which the substrate is moved to an individual processing chamber.

[0169]

In addition, in the manufacturing apparatus shown in FIG. 6, the substrate on which a transparent conductive film (or a metal film (TiN)) is disposed as an anode is carried in, and a layer containing an organic compound is formed, and thereafter, a transparent or semi-transparent cathode (e.g., a laminated layer of a thin metal film (Al or Ag) and a transparent conductive film) is formed, and thereby, it is also possible to form a top emission (or dual emission) light emitting element. Note that the top emission light emitting element means an element which pulls out, through a cathode,

emitted light generated in an organic compound layer.

[0170]

In addition, in the manufacturing apparatus shown in FIG. 6, the substrate on which a transparent conductive film is formed as an anode is carried in, and after a layer containing an organic compound is formed, a cathode formed of a metal film (Al or Ag) is formed, and thereby, it is also possible to form a bottom emission light emitting element. Note that the bottom emission light emitting element means an element which pulls out emitted light generated in an organic compound layer from an anode which is a transparent electrode toward a TFT, and further, which gets the emitted light through the substrate.

[0171]

In addition, it is possible to freely combine this embodiment with Embodiment Mode 1, Embodiment Mode 2, Embodiment Mode 3, Embodiment Mode 4, or Embodiment 1.

[0172]

[Embodiment 3]

In this embodiment, an example for fabricating a light emitting device (top emission structure) which has a light emitting element in which an organic compound layer is used as a light emitting layer over a substrate which has an insulating surface is shown in FIGS. 9.

[0173]

Note that FIG. 9(A) is a top view showing a light emitting device, and FIG. 9(B) is a cross-sectional view taken along A-A' in FIG. 9A. 1101 shown by a dotted line designates a source signal line drive circuit, and 1102 designates a pixel portion, and 1103 designates a gate signal line drive circuit. In addition, 1104 designates a

transparent seal substrate, and 1105 designates a first seal member, and an inside surrounded by the first seal member is filled with a transparent second seal member 1107. Note that in the first seal member 1105, included is a gap member for holding a substrate interval.

[0174]

Note that 1108 designates a wiring for transferring a signal which is imputed to the source signal line drive circuit 1101 and the gate signal line drive circuit 1103, and it accepts a video signal and a clock signal from an FPC (Flexible Print Circuit) 1109 which becomes an external input terminal. Note that here, only the FPC is shown, but a printed wiring board (PWB) may be attached to this FPC.

[0175]

Next, a cross-sectional structure will be described by use of FIG. 9(B). A drive circuit and a pixel portion are formed over a substrate 1110, but here, the source signal line drive circuit 1101 as the drive circuit and the pixel part 1102 are shown.

[0176]

Note that in the source signal line drive circuit 1101, formed is a CMOS circuit in which an n-channel type TFT 1123 and a p-channel type TFT 1124 are combined. In addition, a TFT which forms the drive circuit may be formed by a known CMOS circuit, PMOS circuit or NMOS circuit. In addition, in this embodiment, shown is a driver integral type in which a drive circuit is formed over a substrate, but it is not necessary required, and it is possible to form a drive circuit not over the substrate but outside. In addition, a structure of a TFT in which a polysilicon film is used as an active layer is not particularly restrictive, and may be a top gate type TFT or a bottom gate type TFT.

[0177]

In addition, the pixel portion 1102 is formed of a plurality of pixels which include a switching TFT 1111, a current control TFT 1112, and a first electrode (anode) 1113 electrically connected to its drain. As the current control TFT 1112, either an n-channel type TFT or a p-channel type TFT may be acceptable, but in the case where it is connected to an anode, it is preferable to use a p-channel type TFT. In addition, it is preferable to properly dispose a storage capacitor (not shown). Note that here, among pixels placed in countless numbers, only a cross-sectional structure of one pixel is shown, and an example in which two TFTs are used for the one pixel is shown, but three or more TFTs may be properly used.

[0178]

Here, since it is of such a structure that the first electrode 1113 is in directly contact with a drain of a TFT, it is desirable that a lower layer of the first electrode 1113 be made to be a material layer which can obtain an ohmic contact with a drain which is formed of silicon, and a top layer which is in contact with a layer containing an organic compound be made to be a material layer with a large work function. For example, if employed is a three-layer structure of a titanium nitride film, a film whose main component is aluminum, and a titanium nitride film, resistance of a wiring is low, a good ohmic contact is obtained, and the first electrode 1113 can be made to function as an anode. In addition, the first electrode 1113 may be a single layer of a titanium nitride film, a chromium film, a tungsten film, a Zn film, a Pt film or the like, and a laminated layer of three layers or more may be used.

[0179]

In addition, over both ends of the first electrode (anode) 1113, formed is an insulator (called a bank, a partition wall, a barrier, or a mound) 1114. The insulator 1114 may be formed of an organic resin film or an insulating film which contains

silicon. Here, as the insulator 1114, an insulator of a shape shown in FIG. 9 is formed using a positive type photosensitive acryl resin film.

[0180]

In order to make coverage better, it is designed in such a manner that a curved surface having curvature is formed on an upper end part or a lower end part of the insulator 1114. For example, in the case where a positive type photosensitive acryl is used as a material of the insulator 1114, it is preferable to make only the upper end part of the insulator 1114 have a curved surface having a curvature radius (0.2 μm to 3 μm). In addition, as the insulator 1114, it is possible to use any one of a negative type which becomes irresolvable in etchant by photosensitive light, and a positive type which becomes resolvable in etchant by light.

[0181]

In addition, the insulator 1114 may be covered with a protective film which is composed of an aluminum nitride film, an aluminum nitride oxide film, a thin film whose main component is carbon, or a silicon nitride film.

[0182]

In addition, on the first electrode (anode) 1113, a layer 1115 which contains an organic compound is selectively formed by a vapor deposition method, over introducing monosilane gas. Further, over the film 1115 which contains an organic compound, a second electrode (cathode) 1116 is formed. As the cathode, a material with a small work function (Al, Ag, Li, Ca, or an alloy of any of them, such as MgAg, MgIn, AlLi, CaF_2, or CaN) may be used. Here, in order that emitted light is transmitted, as the second electrode (cathode) 1116, used is a laminated layer of a metal thin film whose film thickness is thinned, and a transparent conductive film (ITO (indium oxide-tin oxide alloy), an indium oxide-zinc oxide alloy (In_2O_3-ZnO), zinc

oxide (ZnO), or the like.). In this manner, a light emitting element 1118 composed of the first electrode (anode) 1113, the layer 1115 which contains an organic compound, and the second electrode (cathode) 1116 is formed. In this embodiment, for the layer 1115 which contains an organic compound, an aromatic diamine layer (TPD), a p-EtTAZ layer, an Alq_3 layer, an Alq_3 layer doped with Nile red, and an Alq_3 layer are laminated in sequence, so that white color light emission is obtained. In this embodiment, since the light emitting element 1118 is an example of white color light emission, a color filter (for the purpose of simplification, an overcoat layer is not shown here), which is composed of a color layer 1131 and a light shielding layer (BM) 1132, is disposed.

[0183]

In addition, if layers containing organic compounds, by which light emissions of R, G, and B are obtained are selectively formed, it is possible to obtain full-color display even without a color filter.

[0184]

In addition, in order to seal the light emitting element 1118, a transparent protective layer 1117 is formed. As this transparent protective layer 1117, it is preferable to use an insulating film which is obtained by a sputtering method (a DC system or an RF system) or a PCVD method and in which silicon nitride or silicon nitride oxide is a main component, a thin film in which carbon is a main component (a DLC film, a CN film, or the like), or a laminated layer of these. If the transparent protective film 1117 is formed using a silicon target, in atmosphere containing nitrogen and argon, it is possible to obtain a silicon nitride film with a high blocking effect against an impurity such as moisture and alkali metal. Further, a silicon nitride target may be used. Further, the transparent protective layer may be formed by using a film

forming apparatus which uses remote plasma. Further, in order that emitted light is transmitted through the transparent protective layer, it is preferable that a film thickness of the transparent protective layer is as thin as possible.

[0185]

In addition, in order to seal the light emitting element 1118, under inert gas atmosphere, the seal substrate 1104 is attached by the first seal member 1105 and the second seal member 1107. Note that as the first seal member 1105 and the second seal member 1107, it is preferable to use an epoxy series resin. In addition, it is desirable that the first seal member 1105 and the second seal member 1107 are of a material through which moisture and oxygen do not pass as much as possible.

[0186]

In addition, in this embodiment, as a material which composes the seal substrate 1104, it is possible to use a glass substrate, a quartz substrate, a plastic substrate which is formed of FRP (fiberglass-reinforced plastics), PVF (polyvinyl fluoride), a mylar, polyester, or acryl, or the like. In addition, after the seal substrate 1104 is attached by using the first seal member 1105 and the second seal member 1107, it is possible to seal by a third seal member so as to further cover a side surface (exposed surface).

[0187]

Thus, by encapsulating a light emitting element in the first seal member 1105 and the second seal member 1107, it is possible to completely shield the light emitting element from outside, and it is possible to prevent a substance such as moisture and oxygen, which urges deterioration of an organic compound layer from being intruded from outside. Therefore, it is possible to obtain a light emitting device with high reliability.

[0188]

In addition, if a transparent conductive film is used as the fist electrode 1113, it is possible to fabricate a dual emission light emitting device.

[0189]

In addition, in this embodiment, shown is an example of such a structure (hereinafter called a top emission structure) that a layer which contains an organic compound is formed over an anode, and a cathode which is a transparent electrode is formed over the layer which contains an organic compound, but a structure which has a light emitting element in which a layer which contains an organic compound is formed over an anode and a cathode is formed over an organic compound layer, and in which emitted light generated in the layer which contains an organic compound, is pulled out from the anode which is a transparent electrode toward a TFT (hereinafter called a bottom emission structure) may be used.

[0190]

Here, one example of a light emitting device of the bottom emission structure is shown in FIGS. 10.

[0191]

Note that FIG. 10(A) is a top view showing a light emitting device, and FIG. 10(B) is a cross-sectional view taken along A-A' in FIG. 10(A). 1201 shown by a dotted line designates a source signal line drive circuit, 1202 designates a pixel portion, and 1203 designates a gate signal line drive circuit. In addition, 1204 designates a seal substrate, and 1205 designates a seal member in which included is a gap member for holding an interval of a hermetically enclosed space, and an inside surrounded by the seal member 1205 is filled with an inert gas (typically, nitrogen). As to an inside space surrounded by the seal member 1205, minute amounts of moisture are removed

by a drying agent 1207 and it is sufficiently dried.

[0192]

Note that 1208 designates a wiring for transferring a signal which is inputted to the source signal line drive circuit 1201 and the gate signal line drive circuit 1203, and it accepts a video signal and a clock signal from an FPC (flexible printed circuit) 1209 which becomes an external input terminal.

[0193]

Next, a cross-sectional structure will be described by use of FIG. 10(B). A drive circuit and a pixel portion are formed over a substrate 1210, but here, the source signal line drive circuit 1201 as the drive circuit and the pixel portion 1202 are shown. Note that in the source signal line drive circuit 1201, formed is a CMOS circuit in which an n-channel type TFT 1223 and a p-channel type TFT 1224 are combined.

[0194]

In addition, the pixel portion 1202 is formed of a plurality of pixels which include a switching TFT 1211, a current control TFT 1212, and a first electrode (anode) 1213 which is comprised of a transparent conductive film electrically connected to its drain.

[0195]

Here, it is of such a structure that the first electrode 1213 is formed so as to be partially overlapped with a connection electrode, and the first electrode 1213 is electrically connected to a drain region of a TFT through the connection electrode. The first electrode 1213 has transparency, and it is desirable to use a conductive film with a large work function (ITO (indium oxide-tin oxide alloy), an indium oxide-zinc oxide alloy (In_2O_3-ZnO), zinc oxide (ZnO), or the like).

[0196]

In addition, over each of ends of the first electrode (anode) 1213, formed is an insulator (called a bank, a partition wall, a barrier, a mound) 1214. In order to make coverage better, it is designed in such a manner that a curved surface having curvature is formed over an upper end part or a lower end part of the insulator 1214. In addition, the insulator 1214 may be covered with a protective film which is composed of an aluminum nitride film, an aluminum nitride oxide film, a thin film in which carbon is a main component, or a silicon nitride film.

[0197]

In addition, over the first electrode (anode) 1213, a layer 1215 which contains an organic compound is selectively formed by carrying out vapor deposition of an organic compound material, over introducing a monosilane gas. Further, over the film 1215 which contains an organic compound, a second electrode (cathode) 1216 is formed. As the cathode, a material with a small work function (Al, Ag, Li, Ca, or an alloy of any of them, such as MgAg, MgIn, AlLi, CaF_2, or CaN) may be used. In this manner, a light emitting element 1218 which is composed of the first electrode (anode) 1213, the layer 1215 which contains an organic compound, and the second electrode (cathode) 1216 is formed. The light emitting element 1218 emits light in a direction shown by the arrow in FIG. 10. Here, the light emitting element 1218 is one of light emitting elements which can obtain single color light emission of R, G, or B, and full-color is realized by three light emitting elements in each of which a layer which contains an organic compound, by which light emission of R, G, or B is obtained, is selectively formed.

[0198]

In addition, in order to seal the light emitting element 1218, a protective layer 1217 is formed. As this transparent protective layer 1217, it is preferable to use an

insulating film which is obtained by a sputtering method (a DC system or an RF system) or a PCVD method and in which silicon nitride or silicon nitride oxide is a main component, or a thin film in which carbon is a main component (a DLC film, a CN film, or the like), or a laminated layer of these. If the protective layer 1217 is formed using a silicon target, in an atmosphere containing nitrogen and argon, it is possible to obtain a silicon nitride film with a high blocking effect against an impurity such as moisture and alkali metal. Further, a silicon nitride target may be used. Further, the protective layer may be formed by using a film forming apparatus which uses remote plasma.

[0199]

In addition, in order to seal the light emitting element 1218, under an inert gas, the seal substrate 1204 is attached by the seal member 1205. In the seal substrate 1204, a concave part has been formed in advance by a sandblast method, and the drying agent 1207 is attached to the concave part. Note that as the seal member 1205, it is preferable to use an epoxy series resin. In addition, it is desirable that the seal member 1205 be of a material through which moisture and oxygen do not pass as much as possible.

[0200]

In addition, in this embodiment, as a material which composes the seal substrate 1104 having the concave part, it is possible to use a plastic substrate which is formed of FRP (fiberglass-reinforced plastics), PVF (polyvinyl fluoride), a mylar, polyester, acryl, or the like. In addition, it is possible to seal by a metal can to an inside of which a drying agent is attached.

[0201]

Further, it is possible to freely combine this embodiment with any one of

Embodiment Modes 1 to 4, Embodiment 1, or the Embodiment 2.

[0202]

[Embodiment 4]

In this embodiment, a cross-sectional structure of one pixel, in particular, a connection of a light emitting element and a TFT, and a shape of a partition wall which is located between pixels will be described.

[0203]

In FIG. 11(A), 40 designates a substrate, 41 designates a partition wall (also called a bank), 42 designates an insulating film, 43 designates a first electrode (anode), 44 designates a layer which contains an organic compound, 45 designates a second electrode (cathode), and 46 designates a TFT.

[0204]

In the TFT 46, 46a designates a channel forming region, 46b and 46c designate a source and a drain region, 46 designates a gate electrode, and 46e and 46f designate a source and a drain electrode. Here, a top-gate type TFT is shown, but it is not restrictive, and an inversely staggered type TFT or a forward staggered type TFT may be used. Note that 46f designates an electrode for connecting with the TFT 46 by being overlapped with the first electrode 43 partially in contact with it.

[0205]

In addition, a cross-sectional structure, which is partially different from that of FIG. 11(A), is shown in FIG. 11(B).

[0206]

In FIG. 11(B), an overlapping way of the first electrode and the electrode is different from the structure of FIG. 11(A), and after the first electrode is patterned, the electrode is formed so as to be partially overlapped with the first electrode, and thereby,

it is connected to a TFT.

[0207]

In addition, a cross-sectional structure, which is partially different from FIG. 11(A), is shown in FIG. 11(C).

[0208]

In FIG. 11(C), a layer of an interlayer insulating film is further disposed, and the first electrode is connected to the electrode of a TFT through a contact hole.

[0209]

In addition, as a cross-sectional shape of the partition wall 41, as shown in FIG. 11(D), it may be a tapered shape. It is obtained by etching a non-photosensitive organic resin or an inorganic film after a resist is exposed to light by using a photolithography method.

[0210]

In addition, if a positive type photosensitive organic resin is used, it is possible to make a shape shown in FIG. 11(E), a shape having a curved surface over an upper end part.

[0211]

In addition, if a negative type photosensitive organic resin is used, it is possible to make a shape shown in FIG. 11(F), a shape having curved surfaces over an upper end part and a lower end part.

[0212]

Further, it is possible to freely combine this embodiment with Embodiment Mode 1, Embodiment Mode 2, Embodiment Mode 3, Embodiment Mode 4, Embodiment 1, Embodiment 2, or Embodiment 3.

[0213]

[Embodiment 5]

In this embodiment, an example of fabricating a passive matrix type light emitting device (also called a simple matrix type light emitting device) will be described.

[0214]

Firstly, over a glass substrate, a plurality of first wirings are formed in a stripe shape by a material such as ITO (a material which becomes an anode). Then, a partition wall which is formed of a resist or a photosensitive resin is formed so as to surround a region which becomes a light emitting region. Then, by a vapor deposition method, a layer which contains an organic compound is formed in a region surrounded by the partition wall. In the case of realizing full-color display, a material is properly selected, and over introducing monosilane gas, the layer which contains an organic compound is formed by a vapor deposition method. Then, over the partition wall and the layer which contains an organic compound, a plurality of second wirings in a stripe shape are formed by a metal material (a material which becomes a cathode) such as Al or an Al alloy, so as to be crossed with the plurality of first wirings which is composed of ITO. By the above-described process, it is possible to form a light emitting element in which the layer containing an organic compound is used as a light emitting layer.

[0215]

Then, a seal substrate is attached by a seal member, or sealed by disposing a protective film over the second wiring. As the seal substrate, used is a glass substrate, a plastic substrate which is formed of a systhetic resin such as polypropylene, polypropylene sulfide, polycarbonate, polyetherimide, polyphenylene sulfide, polyphenylene oxide, polysulfone, or polyphtalamide.

[0216]

One example of a cross-sectional view of a display device of this embodiment is shown in FIG. 12(A).

[0217]

Disposed is a pixel portion 1321 in which a first electrode and a second electrode are crossed over a main surface of a substrate 1300, and a light emitting element is formed at its intersection. That is, formed is the pixel part 1321 in which luminescent pixels are arranged in matrix. The number of pixels is 640 × 480 dots in the case of VGA specification, 1024 × 768 dots in the case of XGA specification, 1365 × 1024 dots in the case of SXGA specification, and 1600 × 1200 dots in the case of UXGA specification, and the number of the first electrodes and the second electrodes are disposed in accordance with it. Further, on the periphery of the pixel portion 1321, which is an end part of the substrate 1301, disposed is an input terminal part in which formed is a terminal pad which is connected to an external circuit.

[0218]

In the display device shown in FIG. 12(A), in the pixel portion, over a main surface of the substrate 1300, formed are a first electrode 1302 which is extended in a left and right directions, a thin film 1305 (since it includes a medium which emits light by electroluminescence, as a matter of convenience, it is called an EL layer in the following description) which includes an illuminant formed over its upper layer, and a second electrode 1306 which is formed over its upper layer and extended in an up and down directions, and at its intersection, a pixel is formed. That is, by forming the first electrode 1302 and the second electrode 1306 in a row and column directions, pixels are disposed in a matrix. An input terminal is formed of the same material as the first electrode or the second electrode. The number of this input terminal is the same as

the number of the first electrode and the second electrode which are disposed in a row and column directions.

[0219]

A cross-sectional shape of the partition wall 1304 has a curved surface shape from a lower end part which is in contact with the first electrode 1302 to an upper end part. The curved surface shape is a shape which has at least one curvature radius, a center of which is located at the partition wall or a lower layer side thereof, or, a shape which has at least one first curvature radius, a center of which is located at a lower end part which is in contact with the first electrode 1302 and at an outside of the partition wall 1304, and at least one second curvature radius, a center of which is located at an upper end part of the partition wall 1304 and at the partition wall or a lower layer side thereof. The cross-sectional shape may be such that curvature is continuously changed from the lower end part to the upper end part of the partition wall 1304. The EL layer is formed along the curved surface shape, and stress is mitigated by the curved surface shape. That is, in a light emitting element in which different members are laminated, there is such an operation that strain due to its thermal stress is mitigated.

[0220]

Shown is such a mode that an opposite substrate 1350 for sealing the pixel part 1321 is firmly fixed by a seal member 1341. In a space between the substrate 1301 and the opposite substrate 1350, an inert gas may be filled, or an organic resin material 1340 may be encapsulated. In any case, since a light emitting element in the pixel portion 1321 is coated with a barrier insulating film 1307, it is possible to prevent deterioration due to an extrinsic impurity, even if a drying agent is not disposed particularly.

[0221]

In addition, in FIG. 12(A), on the opposite substrate 1350 side, formed are color layers 1342 to 1344 corresponding to pixels of the pixel part 1321. A planarization layer 1345 prevents a step due to the color layer. On the other hand, FIG. 12(B) is of such a structure that, on the substrate 1301 side, disposed are the color layers 1342 to 1344, and over the planarization film 1345, the first electrode 1302 is formed. In addition, FIG. 12(B) is different from FIG. 12(A) in a light emitting direction. Note that the same reference numerals are used for the same portions.

[0222]

In addition, this invention is not restricted to a full-color display device, and can be implemented for a single color light emitting device, for example, a surface light source or an electric illumination apparatus.

[0223]

In addition, it is possible to freely combine this embodiment with any one of Embodiment Modes 1 to 4, Embodiment 1, or Embodiment 2.

[0224]

[Embodiment 6]

By incorporating a light emitting device obtained by implementing this invention in a display part, it is possible to fabricate electronic equipment. As the electronic equipment, cited are a video camera, a digital camera, a goggle type display (headmount display), a navigation system, a sound reproducing apparatus (a car audio, an audio component stereo, or the like), a notebook type personal computer, game equipment, a portable information terminal (a mobile computer, a portable telephone, a portable type game machine, an electronic book, or the like), an image reproducing device which has a recording medium (concretely speaking, a device which reproduces

a recording medium such as digital versatile disc (DVD) and has a display which can display its image), and the like. Concrete examples of the electronic equipment are shown in FIG. 13.

[0225]

FIG. 13(A) shows a television which includes a housing 2001, a support table 2002, a display part 2003, a speaker part 2004, a video input terminal 2005, and the like. This invention is applicable to the display part 2003. Note that all information display televisions for personal computer use, TV broadcasting receiving use, and advertisement display use are included.

[0226]

FIG. 13(B) shows a digital camera which includes a main body 2101, a display part 2102, an image receiving part 2103, an operating key 2104, an external connection port 2105, a shutter 2106, and the like. This invention is applicable to the display part 2102.

[0227]

FIG. 13(C) shows a notebook type personal computer which includes a main body 2201, a housing 2202, a display part 2203, a keyboard 2204, an external connection port 2205, a pointing mouse 2206, and the like. This invention is applicable to the display part 2203.

[0228]

FIG. 13(D) shows a mobile computer which includes a main body 2301, a display part 2302, a switch 2303, an operating key 2304, an infrared port 2305, and the like. This invention is applicable to the display part 2302.

[0229]

FIG. 13(E) shows a portable type image reproducing device (concretely

speaking, a DVD reproducing device) which has a recording medium, which includes a main body 2401, a housing 2402, a display part A 2403, a display part B 2404, a recording medium (DVD or the like) reading part 2405, an operating key 2406, a speaker part 2407, and the like. The display part A 2403 displays mainly image information, and the display part B 2404 displays mainly textual information, and this invention is applicable to the display parts A and B 2403 and 2404. Note that home-use game equipment and the like are also included in the image reproducing device which has a recording medium.

[0230]

FIG. 13(F) shows game equipment which includes a main body 2501, a display part 2505, an operating switch 2504, and the like.

[0231]

FIG. 13(G) shows a video camera which includes a main body 2601, a display part 2602, a housing 2603, an external connection port 2604, a remote controller receiving part 2605, an image receiving part 2606, a battery 2607, a sound input part 2608, an operating key 2609, and the like. This invention is applicable to the display part 2602.

[0232]

FIG. 13(H) shows a portable telephone which includes a main body 2701, a housing 2702, a display part 2703, a sound input part 2704, a sound output part 2705, an operating key 2706, an external connection port 2707, an antenna 2708, and the like. This invention is applicable to the display part 2703. Note that by displaying a white color character on a black color background on the display part 2703, it is possible to suppress a consumption current of the portable telephone..

[0233]

As above, a display device obtained by implementing this invention may be used as a display part of any electronic equipment. Note that in the electronic equipment of this embodiment mode, a light emitting device fabricated by using any structure of Embodiment Modes 1 to 4 and Embodiments 1 to 5 may be used.

[0234]

[Effect of the Invention]

According to this invention, it is possible to form a high-density organic compound layer by carrying out vapor deposition of an organic compound film over introducing a material gas, by having a component of the material gas contained in the organic compound film, and by carrying out film formation up to a desired film thickness. According to this invention, by intentionally introducing a material gas at the time of film formation, a high-density film is obtained, and an impurity such as oxygen and moisture, which causes deterioration, is blocked from intruding and diffusing in a film.

[0235]

Further, according to thus invention, it is possible to fit more molecules between layers. In particular, in the case of forming a mixed region, it is possible to fit more between molecules in the mixed region. Therefore, further, it becomes possible to prevent reduction of a drive voltage and luminance lowering.

[Brief Description of the Drawings]

[FIG. 1] A film forming apparatus of this invention (Embodiment Mode 1)

[FIG. 2] A film forming apparatus of this invention (Embodiment Mode 2).

[FIG. 3] A film forming apparatus of this invention (Embodiment Mode 3)

[FIG. 4] A film forming apparatus of this invention (Embodiment Mode 4)

[FIG. 5] A diagram for illustrating an element structure which is fabricated by the film

forming apparatus of this invention (Embodiment 1)

[FIG. 6] A diagram showing a multi-chamber system manufacturing apparatus (Embodiment 2)

[FIG. 7] A diagram showing a crucible transport in an installation chamber (Embodiment 2)

[FIG. 8] A diagram showing a crucible transport to a vapor deposition source holder in the installation chamber (Embodiment 2)

[FIG. 9] A diagram showing Embodiment 3

[FIG. 10] A diagram showing Embodiment 3

[FIG. 11] A diagram showing an embodiment 4

[FIG. 12] A diagram showing an embodiment 5

[FIG. 13] A diagram showing an embodiment 6

[Document Name] Abstract

[Summary]

[Problem] This invention provides a film forming apparatus and a film forming method, which are used for formation of a high-density EL layer.

[Solving Means] In this invention, a substrates is heated by a heating means for heating a substrate and further, a material gas is introduced over depositing an organic compound material from a vapor deposition source, with 5×10^{-3} Torr (0.665 Pa) or less, preferably 1×10^{-3} Torr (0.133 Pa) or less, which is set by a depressurizing means connected to a film forming chamber, to carry out film formation, so that a high-density EL layer is formed.

[Selected Drawing] FIG. 1